Panel-Envelope - User Manual

Version 12.1

ANSYS, Inc.
Southpointe
275 Technology Drive
Canonsburg, PA 15317
ansysinfo@ansys.com
http://www.ansys.com
(T) 724-746-3304
(F) 724-514-9494

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Revision Information

The information in this guide applies to all ANSYS, Inc. products released on or after this date, until superseded by a newer version of this guide. This guide replaces individual product installation guides from previous releases.

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The following modifications have been incorporated:

Section	Page(s)	Update/Addition	Explanation

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1 INTRODUCTION

PANEL-ENVELOPE is part of the PANEL suite of programs that also includes PANEL-CHECK. The suite is designed to allow the user to rapidly check stiffened and unstiffened plate panel structures against codes of practice such as BS5400, Det Norske Veritas Rules (DnV) and the IDWR (Merrison Rules).

PANEL-ENVELOPE performs the following tasks, it:

- provides an interface between an FE analysis program and PANEL-CHECK to allow stress results from a modelled structure to be used in the PANEL code checks;

- allows the selection of individual or combinations of load cases from the original analysis to be factored, chosen, discarded, reversed and combined using an extensive set of logic instructions;

- converts the basic stress results from shell element FE analyses into components of load in the form required by PANEL-CHECK;

- forms envelopes (maximum and minimum extreme values) of these load components for selected locations in the structure using the above loading logic;

- optionally scans regions of the structure (panels or sections) to determine their geometry and to select locations to be enveloped by their position within the structure. PANEL-ENVELOPE may then produce envelopes of load automatically for all or a sample of the locations identified within the region. This allows PANEL-CHECK data to be generated with a minimum of user input;

- optionally produces overall envelopes of load for all locations of a certain type in a region. This allows rapid first-pass checking of large areas of the structure;

- optionally produces global envelopes over one or more regions to allow first-pass checking of even larger parts of the structure;

- handles dynamic loads alone or in combination with static loading and produces envelopes that correctly allow for individual load phases;

- maintains separate ultimate and characteristic envelopes for strength and serviceability code-checking.

PANEL-ENVELOPE currently interfaces with the ASAS and SESAM FE analysis suites. Data input commands are all free format and the range of geometries handled includes stiffeners modelled with shell elements for webs and beams for flanges, as well as the normal coplanar and offset stiffeners.

This User Manual should be read in conjunction with the PANEL suite Theoretical and Application Manuals, and with the User Manual for PANEL-CHECK.

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2 PROGRAM DESCRIPTION

2.1 OVERVIEW OF THE PANEL SUITE

The PANEL post-processing suite comprises two separate but integrated programs:

– PANEL-ENVELOPE: this will produce envelopes (maximum/minimum ranges) of load for selected locations or regions of the structure across selected load cases. These envelopes will be used for strength and serviceability checks in PANEL-CHECK;

– PANEL-CHECK: this will perform code-checks on selected locations or regions of the structure. Strength, serviceability and fatigue checks may be performed selectively using loads provided by the user or transferred by PANEL-ENVELOPE.

Both of the above programs will interface with a finite element analysis via the binary interface files produced by the FE system in use. The suite of programs may be used in two modes in operation:

– PANEL-CHECK may be used as a stand-alone program accepting all input data and loading from the user. Strength, serviceability and fatigue checks may be performed. There is no interface with any FE system when operating in this mode;

– PANEL-CHECK may interface with the FE system via the PANEL-ENVELOPE program. PANEL-ENVELOPE should be run to scan areas of the structure and identify locations and loads for subsequent checking. PANEL-CHECK may then access the loading stored and perform strength and serviceability checks as required. This facility is particularly useful for rapidly producing checks on large areas of a structure.

Figure 2.1-1 shows the last mode diagrammatically. This figure illustrates the course of post-processing for an FE analysis.

2.2 PROGRAM SCOPE

The PANEL suite is primarily designed to assess unidirectionally stiffened or unstiffened panels. However, orthogonally stiffened panels may also be handled by analysing each direction of stiffening in turn. This approach will give reasonably accurate results when the stiffnesses of the two orthogonal stiffeners are dissimilar and the panel can be handled as a series of small unidirectionally stiffened panels framing between larger transverse frames (Figure 2.2-1). In this case, two PANEL analyses should be performed:

– the smaller longitudinal stiffeners and the plate should be analysed first using dimension (a) as the length and (b) as the spacing of stiffeners;

– the larger transverse stiffeners may then be analysed using dimensions (B) and (a) as the length and spacing respectively. The true thickness of plate must be used to obtain the correct composite properties, but the plate should not be checked for

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buckling as the above dimensions are not valid for the plate.

This approach is slightly conservative as the stiffness of the smaller stiffeners is ignored in determining buckling of the larger stiffeners, but has been shown to be quite accurate for reasonably dissimilar stiffener strengths, and is conservative otherwise.

Stiffener properties may be defined for the following section types:

- tees;
- angles;
- bulb flats;
- flat plates.

The program will consider the following load types acting on the stiffener and plate:

- stiffener direction stress;
- perpendicular stress;
- in-plane shear;
- stiffener-plate bending;
- stiffener-web shear.

No other load types can be considered by the PANEL suite.

2.3 LOAD CASE SELECTION METHODS

Conventional load case selection is performed by creating load combinations selected so as to produce critical stresses in specific locations in the structure. Many such combinations may be required to produce critical stresses in all required locations under all possible combinations of load. It is usually necessary to apply engineering logic to the selection of load combinations so as to reduce the number of cases required. Figure 2.3-1(a) illustrates this approach for a simple continuous beam.

PANEL-ENVELOPE can be used to produce load combinations, as above, by simply combining load cases together within an envelope. Each combination is created as an envelope of load, but with identical maximum and minimum values at each location.

However, a far more powerful facility exists which allows true envelopes of load to be created by selecting or discarding individual load cases depending on their effect on each stress component at a given location in the structure. Figure 2.3-1(b) illustrates this method applied to the same example as above. For each selected location along the beam and for each stress component at that location, PANEL-ENVELOPE will select, from the user-defined set of load cases, only those required to produce both maximum and minimum values of stress and will calculate and store these extreme values. Code-checking in PANEL-CHECK using selected combinations of these maximum and minimum stresses

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will ensure that the most critical load combinations have been selected.

The enveloping approach has the following advantages over the conventional combination method:

- it is more thorough. As long as all possible load cases have been considered, and their loading logic is correctly represented, the maximum absolute range of stress at every location will be calculated. The conventional combination method cannot ensure this if a subset of all possible combinations has been selected;

- it is generally simpler to code the logic for enveloping than to create many different load combinations;

- the cost of the code-checking is greatly reduced as only a few selected combinations of envelope extremes need to be checked, as opposed to a large number of load case combinations;

- the method lends itself very easily to producing envelopes of load over a number of locations in the structure.

There is a disadvantage to enveloping as opposed to combining load cases. This disadvantage is that the various stresses at a given location (direct, bending, etc.) are all enveloped independently and will in general be derived from different constituent cases. It is unlikely that this worst combination of loads will actually occur simultaneously. In the panel checks, however, all components of stress interact to form a single code check which may therefore result from combinations of stresses which cannot occur at the same time.

This problem is always present when enveloping load components, but is acceptable because of the considerable saving in cost against code-checking every load combination in turn. Furthermore, the user always has the option of using PANEL-ENVELOPE to produce simple combinations of load or envelopes of reduced complexity, to recheck areas which fail the original conservative checks. The enveloping procedure may therefore be considered to be a first-pass approach used to eliminate locations and regions of the structure that are not critical. Locations failing these preliminary checks may then be assessed in more detail. This multilevel checking procedure is generally much more efficient in time and computer cost.

2.4 LOAD CASE INCLUSION TABLES

At the heart of the PANEL-ENVELOPE program are the load case inclusion tables which define the logic by which individual FE analysis load cases are combined to form envelopes of load for individual locations in the model.

Each inclusion table generates one envelope of load for each location or panel currently selected. An envelope is defined as a set of maximum and minimum values of a particular load, for a particular location or panel. Table 2.4-1 illustrates the creation of envelopes from constituent load cases. A title for this envelope may be associated with each table of inclusion data. For example, for an offshore structure, the following three envelopes may be generated using three separate inclusion tables:

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Envelope 1	:	'Calm Sea'
Envelope 2	:	'Operating Wave'
Envelope 3	:	'Storm Wave'.

Each line of an inclusion table contains an instruction which defines how a particular load case from the FE analysis is to be included in the envelope and provides factors to apply to this load case for strength and serviceability analysis. Basic load case inclusion table entries are as follows:

INCL	-	always include this load case whether it extends or contracts the current envelope;
REVE	-	this load case is reversible. Include it in either direction to extend both maximum and minimum values;
IFTA	-	include this load case only if it extends the envelope;
CHOO	-	choose a user-specified range of cases from the following list of cases;
LOAD	-	load case in a CHOO list;
WITH	-	combine this load case with the one above and follow its inclusion logic.

There is also a facility to define sub-envelopes. The following commands relate to this:

DEFI	-	start the creation of a sub-envelope;
FINI	-	end the creation of a sub-envelope;
USE	-	use a sub-envelope.

USE may be placed in a CHOOse list to force the program to use previously created sub-envelopes. This option provides very powerful multi-level load case selection. Sub-envelopes may also be used to transfer inclusion lists between service and ultimate cases and to avoid repetition of logic instructions.

The following example shows the use of simple PANEL-ENVELOPE inclusion data to define the loading on an offshore platform:

INCL	dead load
WITH	buoyancy
IFTA	live load
CHOO	from 0 to 1 of the following 4 cases
LOAD	M_X crane moment and hook load
LOAD	M_Y crane moment and hook load
LOAD	$-M_X$ crane moment and hook load
LOAD	$-M_Y$ crane moment and hook load
CHOO	one and only one of the following
LOAD	0° wave loads
LOAD	45° wave loads
LOAD	90° wave loads

In the above example, dead load is always INCLuded, as is buoyancy, which is combined WITH it. Live load is only included IF TAking it extends the envelope (i.e. it is not included if it has a beneficial effect on the envelope). The worst non-beneficial crane load case is chosen if one exists. Finally, the single worst wave case is chosen.

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The above inclusion table is, of course, greatly simplified. In practice:

– each load description may be represented by more than one physical load case using WITH commands (i.e. dead load may comprise components for substructure weight, ballast, topsides, appurtenances, etc.);

– strength and serviceability requirements may be different;

– crane moments about X and Y could be DEFIned as REVErsible loads within two sub-envelopes and then USEd within a CHOOse list;

– a more elegant way of handling crane moments would be to treat them as dynamic loads (M_X at 0° phase, M_Y at 90° phase) and allow the program to determine the phase angle giving maximum envelope extension (see Section 2.8).

Full details of the data formats for all inclusion commands are given in Section 6.0 of this manual. Section 4.0 describes how inclusion data is entered into the program. One useful facility of the program is the ability to be able to enter inclusion data for multiple runs into a separate file and reference this file from each run.

2.5 NODE CLASSIFICATION AND SCANNING

All locations for code-checking within PANEL must be allocated a CLASS which defines the position of this inspection point on the panel. Eight classes are currently valid as described below and illustrated in Figure 2.5-1. These are:

Class 1	–	panel corners;
Class 2	–	stiffener ends;
Class 3	–	unstiffened edges;
Class 4	–	central locations on outer stiffeners;
Class 5	–	central locations on inner stiffeners;
Class 6	–	stiffened edges;
Class 7	-	unstiffened interior locations;
Class 8	-	as Class 2.

The classification is initially used in PANEL-ENVELOPE to define whether or not a stiffener is present at a location. Locations of class 2, 4, 5 and 8 have stiffeners; 1, 3, 6 and 7 do not. The class of a node is further used in PANEL-CHECK to define the type of check to be performed and to control the creation of certain parameters, such as effective width, stress concentration factors, etc. For serviceability and fatigue limit states, it controls the actual stresses produced.

If PANEL-ENVELOPE is being used to check one or more user-specified locations on a panel, then the user is responsible for defining the class of these locations. However, a far more powerful facility exists within PANEL-ENVELOPE whereby the program can automatically classify all nodes that exist across a panel (the panel being defined as a subset of shell and beam elements). PANEL-ENVELOPE will then select all or a standard sample of these classified nodes for enveloping and subsequent code-checking. This facility allows the user to select a large area of the structure and code-check it with the minimum of input data.

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A further useful facility in the program is the ability to be able to produce class envelopes. Class envelopes are global envelopes that bound all individual node envelopes for each class on a panel. If these class envelopes are used for code-checking in PANEL-CHECK and the code-checks prove successful, then all individual nodes of each class will, by definition, also pass the checks. This facility can be used to produce a rapid first-pass check on a panel. If failures occur under this preliminary check, then the user should revert to checking all individual locations of the failing class.

2.6 LOAD CONVERSION

The FE analysis package generally produces nodal stresses per load case for shell and membrane elements, and nodal forces per load case for beam and rod elements. Before any enveloping can be performed, these stresses and forces must be converted into suitable stiffened or unstiffened plate loads depending on the class of node location being assessed. Valid enveloping may only be performed once this conversion is complete.

The PANEL suite stores envelopes internally per condition (strength or serviceability), per extreme (maximum or minimum), as five values of load per location:

N_S	-	load per unit width in stiffener direction;
N_P	-	load per unit width perpendicular to stiffener;
N_{SP}	-	shear flow in plate;
M	-	moment in stiffener/plate per unit width;
S	-	shear force in stiffener web per unit width.

These five load components are shown diagramatically in Figure 2.6-1. M and S are not required for plate locations of Classes 1, 3, 6 and 7 where there are no stiffeners. Storing load data as loads per unit width instead of stresses effectively converts the problem into a load path analysis. The loads per unit width are independent of section size and a revised section can simply be substituted and checked in PANEL-CHECK with modified stresses being calculated automatically. If stress data were transferred, then the programs would need to know the original section sizes to perform this reanalysis.

Appendix C describes the algorithms used to convert analysis stresses and forces into PANEL loads per unit width. Currently, the program can cope with the following forms of modelling of the stiffened plate:

– stiffener effective area smeared over plate to produce artificial increase in thickness or anisotropic properties;

– plate modelled using shell or membrane elements; stiffener modelled using beam or rod elements (with area of stiffener but inertia of composite section);

– plate modelled using shell or membrane elements, but with beam element offset from centre line of plates (and having properties of stiffener alone);

– plate modelled using shell or membrane elements; stiffener web modelled using shell or membrane elements; stiffener flange modelled using rod or bar elements.

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Other modelling options, such as full flange modelling cannot be handled by the program at present.

2.7 ENVELOPES OF STATIC LOAD

For a simple static envelope, each inclusion line is processed in turn in accordance with Section 2.4 and envelopes are created for both strength (ultimate envelope) and serviceability (characteristic envelope) conditions.

For ultimate envelopes, load cases are individually multiplied by a load-factor prior to inclusion in the envelope. The user may specify a range of load-factors (minimum and maximum factors) to be applied as follows:

– the maximum factor is used when the load extends the envelope so that it is augmented by the maximum amount;

– the minimum factor is used when a load reduces the envelope so that the envelope is decreased by the minimum amount. Load cases may be forced to reduce envelopes when specified as a simple INCLude case or when they occur in a CHOOse list with a non-zero minimum number of cases (so that some must be chosen even though they help reduce load). Care should be taken over the use of INCLude and WITH to define ultimate envelopes. This is because the multiplication or division of a load occurs after the WITH lines have been taken into account, resulting in different envelopes for (INCL/INCL) and (INCL/WITH) sequences. Consider the following example:

load case 1: 7 units with max/min load factors of 1.5/1.25;
load case 2: -5 units with max/min load factors of 1.5/1.25.

INCLuding load case 1 WITH load case 2 would result in the following maximum envelopes:

for characteristic envelopes	7 - 5	=	2.0;
for ultimate envelopes	(7 - 5) * 1.25	=	3.0;

whereas INCLuding load case 1 and INCLuding load case 2 would give the following:

for characteristic envelopes	7 - 5	=	2.0, as before;
for ultimate envelopes	7 * 1.5 - 5 * 1.25	=	4.25.

The difference in ultimate envelopes is clear to see. Use of INCL/WITH is appropriate when the two loads are very closely related, so that the value of one is directly dependent on that of the other. The use of INCL/INCL is preferable when both loads are expected but can vary independently.

2.8 ENVELOPES OF DYNAMIC LOAD

Apart from simple static enveloping (composing envelopes based on individual constant single load cases), a useful feature of PANEL-ENVELOPE is its ability to handle dynamic

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load cases. Dynamic loading is assumed to be simple harmonic loading represented physically by two separate load cases phased at 90° to each other. The first of these load cases is termed the 'real part' of the loading whilst the second is the 'imaginary part'. The real and imaginary parts of loading may be represented diagrammatically on an Argand diagram (Figure 2.8-1). This diagram also shows how load cases that are to be INCLuded are vectorially added to produce real and imaginary components and amplitude of load.

PANEL-ENVELOPE performs dynamic enveloping of other load inclusion types by subdividing the Argand diagram into a number of phase sectors. The number of sectors used affects the accuracy of the enveloping and is under the control of the user. Because of symmetry, there is an enveloping time advantage to having an even number of sectors. Figure 2.8-2 shows an Argand diagram subdivided into eight phase sectors.

Each phase sector is now considered in turn. IFTA load cases are included in the envelope for a given sector only if their projection or the centre line of the phase sector is positive (for maximum envelope) and negative (for minimum envelope).

Figure 2.8-2 shows typical inclusion of 11 TA load cases for envelope maxima in the first four phase sectors of an 8-sector Argand diagram. Only those load cases shown would be used to extend the maximum envelope in each sector. All other IFTA load cases would be used to extend the minimum envelope.

It is here that symmetry can be used to reduce the amount of computation. If the number of phase sectors is even, the maximum envelope of IFTA loads in one sector is the same as the minimum envelope in the opposite sector. PANEL-ENVELOPE takes advantage of this to reduce the computation time.

PANEL-ENVELOPE treats CHOOse instructions in a similar sector by sector fashion. All items in the CHOOse list are projected onto the sector centre line and a number of cases chosen (between the upper and lower limits specified in the instruction) so that a true maximum or minimum envelope is obtained.

The WITH facility is available for dynamic load combinations, but REVErsible is not. Should REVE be required, it can be simulated by IFTA as follows:

IFTA load case factored by +1.0;
IFTA load case factored by -1.0.

The final dynamic envelopes per sector are obtained by summing the INCL load cases with any other load cases selected for that phase sector, for both maximum and minimum envelope limits.

Note that transient (time history) loads are not harmonic in nature and may be treated as simple static loads at each time step.

2.9 ENVELOPES OF COMBINED STATIC AND DYNAMIC LOADS

Static loading and dynamic loading are often independent of each other. In this case the static and dynamic loads may be enveloped independently. Then the results can be added together suitably to determine the overall envelope values.

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However, in some cases the choices of static loading and dynamic loading are interdependent. For example, for a tension leg offshore platform, one tether at any time may be removed for inspection. If the static and dynamic effects were enveloped separately, some envelopes would almost certainly contain load combinations where, for static loading one tether was removed, but for dynamic loading a different tether was removed. This is overcome by the use of the combined static and dynamic enveloping facility. In the combined section, the choice of loading which gives the worst effect for any phase sector is based on the sum of the static load, plus the component of the dynamic load resolved onto the phase sector centre line.

Load factors are applied separately to the static and dynamic parts of the load and it is possible for the static load to be multiplied by its load factor, but the dynamic load to be divided by its load factor.

Note, however, that symmetry cannot be used to halve the number of phase sectors processed as is possible with pure dynamic enveloping. The static loads produce an assymmetric 'offset' to the envelopes such that the maximum envelope values in one sector are not the same as the minimum envelope values in the opposite sector. This means that combined loads take twice as much processing as pure dynamic loads, and the "number-of-sectors" times as much processing as simple static cases. For optimum efficiency, much of the static and dynamic enveloping can usually be performed separately as sub-envelopes, which can then be USEd to form the combined envelopes.

2.10 ENVELOPING ACCURACY OVER SECTORS

The number of sectors selected for enveloping of dynamic loads affects the accuracy of the final envelopes, but has an adverse affect on computation time and cost. In general, the more sectors selected, the greater the accuracy and cost.

As an aid to selecting the minimum number of sectors required to envelope a given load, the following notes may prove helpful.

The program is at present set up to handle two, four, six and eight sectors. Mathematically, the maximum error of the enveloping procedure for N sectors is given by:

Maximum Error = 100 - 100*(cos(360/(2N)))%

For the range of sectors (N) considered:

No of Sectors	Maximum Error
2	Infinite
4	41%
6	15%
8	8%

However the method appears to be very much more accurate in practice than these figures suggest due to scatter of individual load case phases. Trials on locations selected to be likely to produce inaccuracy showed that using two sectors gave good results with a maximum error of under 20%. Using four sectors gave results that were very nearly the same as the eight sector values. It is therefore recommended that four sectors are used. The default value is set at eight sectors.

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Case	Axial Load	Trans-verse Load	In-Plane Shear	Moment	Out-of-Plane Shear
1	-3.02	-0.21	2.20	-22.31	-0.032
2	-6.13	-1.16	2.31	-12.62	-0.141
3	5.20	-0.16	3.62	-19.83	0.203
4	4.19	0.21	4.10	-7.14	0.013
5	1.63	-0.86	1.86	-25.99	0.222
6	-2.16	0.10	3.13	-24.00	-0.111
CONSTITUENT LOAD CASE					

Case	Axial Load	Trans-verse Load	In-Plane Shear	Moment	Out-of-Plane Shear
MAXIMA	5.20	0.21	4.10	-7.14	0.222
MINIMA	-6.13	-1.16	1.86	-24.00	-0.141
RESULTING ENVELOPES					

TABLE 2.4-1: EXAMPLE OF ENVELOPE CREATION

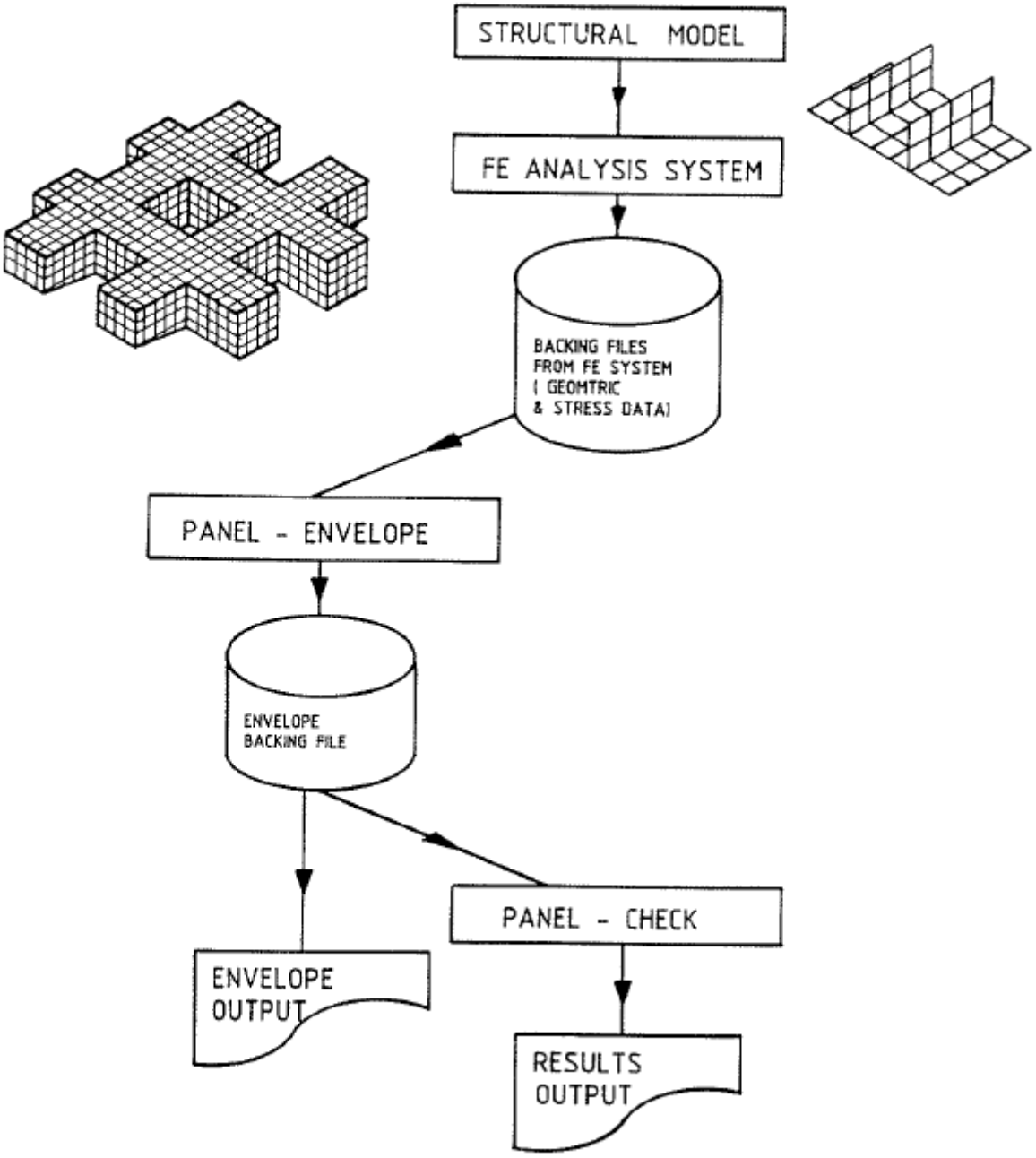

FIGURE 2.1-1: USE OF THE PANEL PROGRAM

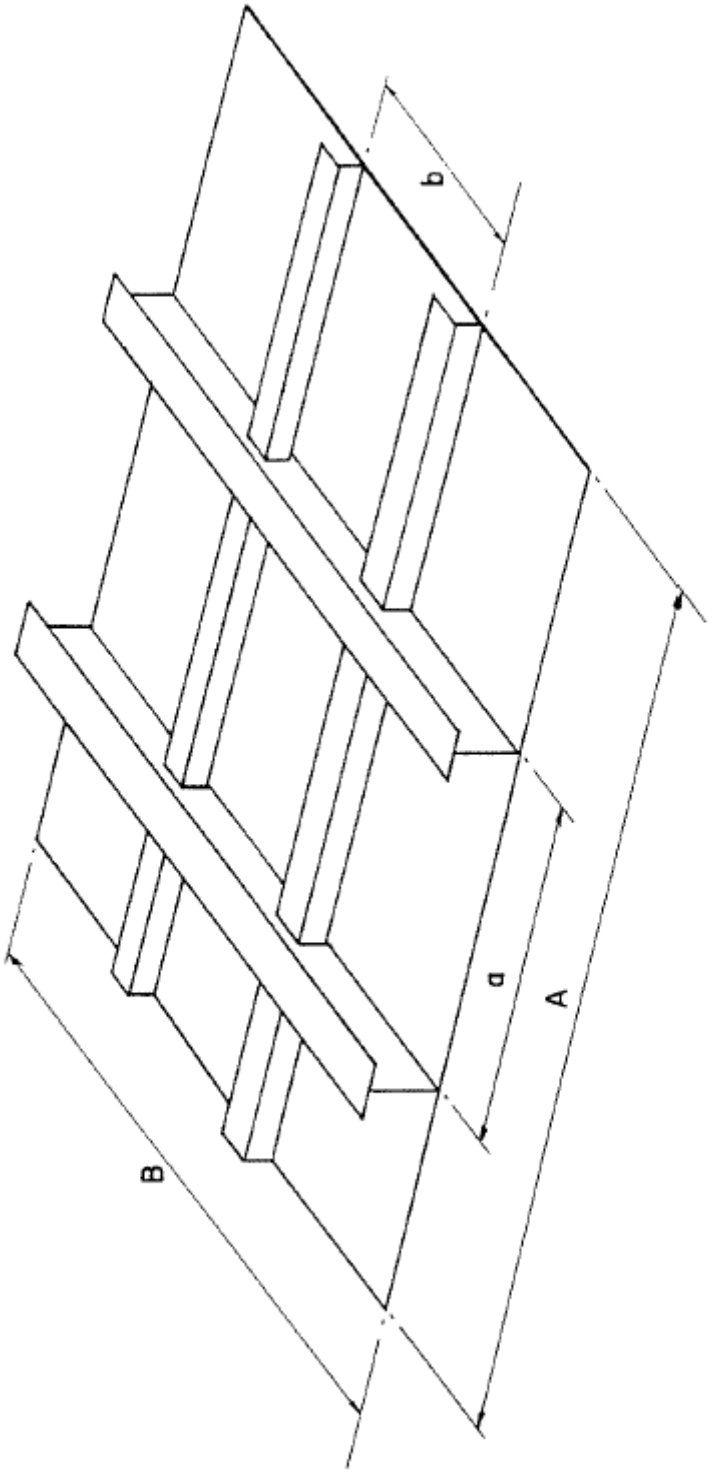

FIGURE 2.2-1: ORTHOGONALLY STIFFENED PANEL

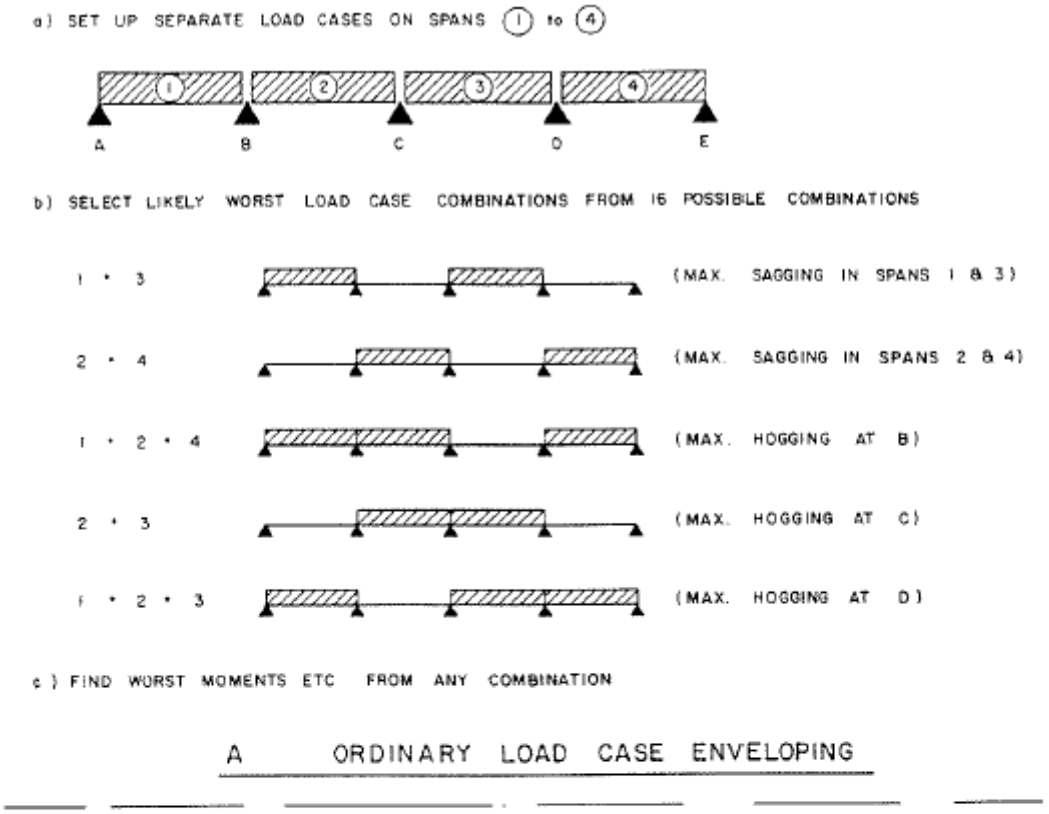
a) SET UP SEPARATE LOAD CASES ON SPANS (1) to (4)
A
B
C
D
E
b) SELECT LIKELY WORST LOAD CASE COMBINATIONS FROM 16 POSSIBLE COMBINATIONS
1 • 3
(MAX. SAGGING IN SPANS 1 & 3)
2 • 4
(MAX. SAGGING IN SPANS 2 & 4)
1 • 2 • 4
(MAX. HOGGING AT B)
2 • 3
(MAX. HOGGING AT C)
1 • 2 • 3
(MAX. HOGGING AT D)
c) FIND WORST MOMENTS ETC FROM ANY COMBINATION
A ORDINARY LOAD CASE ENVELOPING
a SET UP SEPARATE LOAD CASES ON SPANS (1) to (4)
A
B
C
D
E
b) DEFINE LOGIC OF LOADING COMBINATIONS
CHOOSE BETWEEN 0 & 4 OF THE FOLLOWING
LOAD CASE 1
LOAD CASE 2
LOAD CASE 3
LOAD CASE 4
c) PROGRAM DETERMINES THE ENVELOPE OF MOMENTS ETC. FROM THE GIVEN LOGIC
B LOGIC ENVELOPING

FIGURE 2.3-1: ENVELOPING EXAMPLES

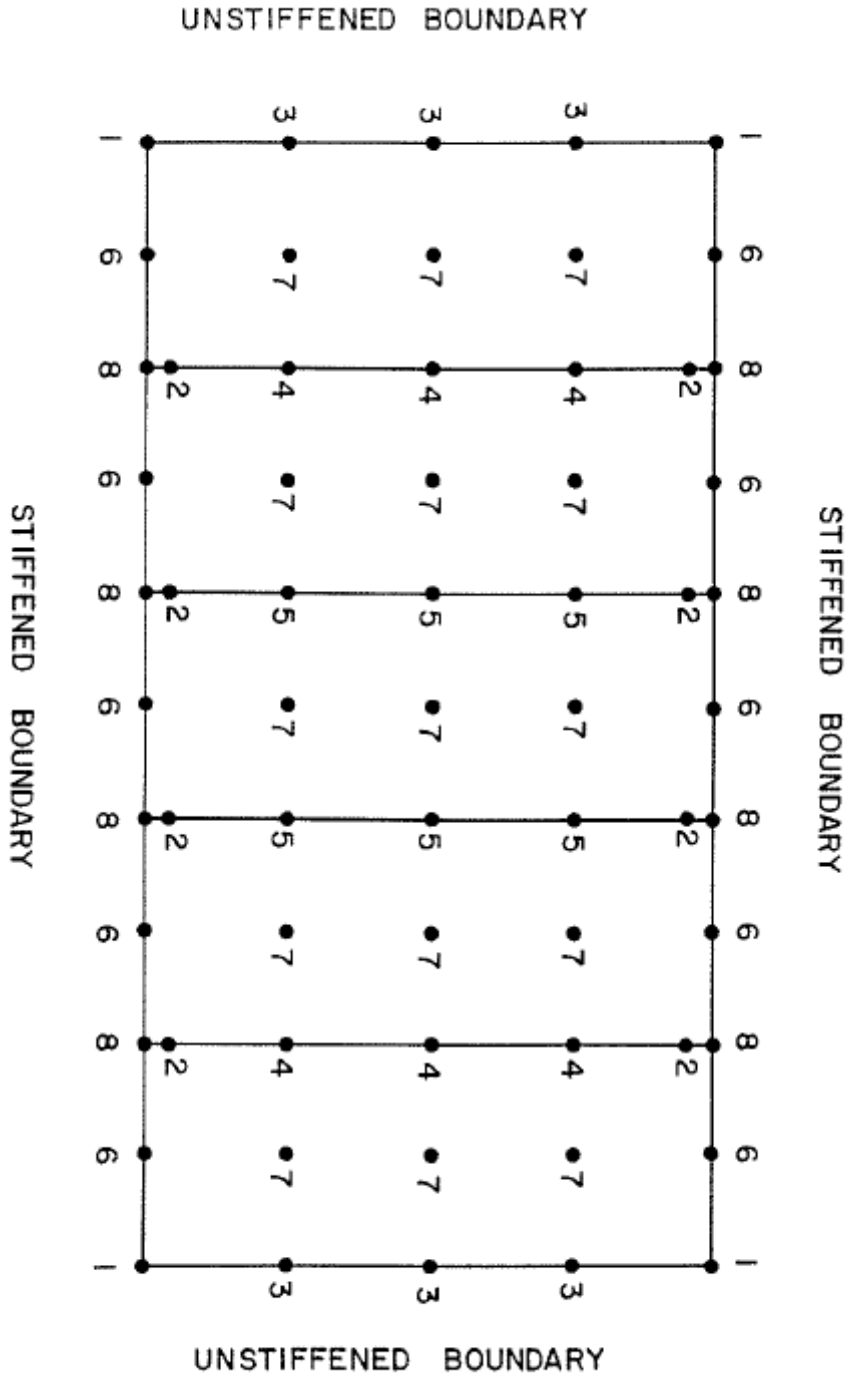

FIGURE 2.5-1: STIFFENED PANEL CLASSIFICATION

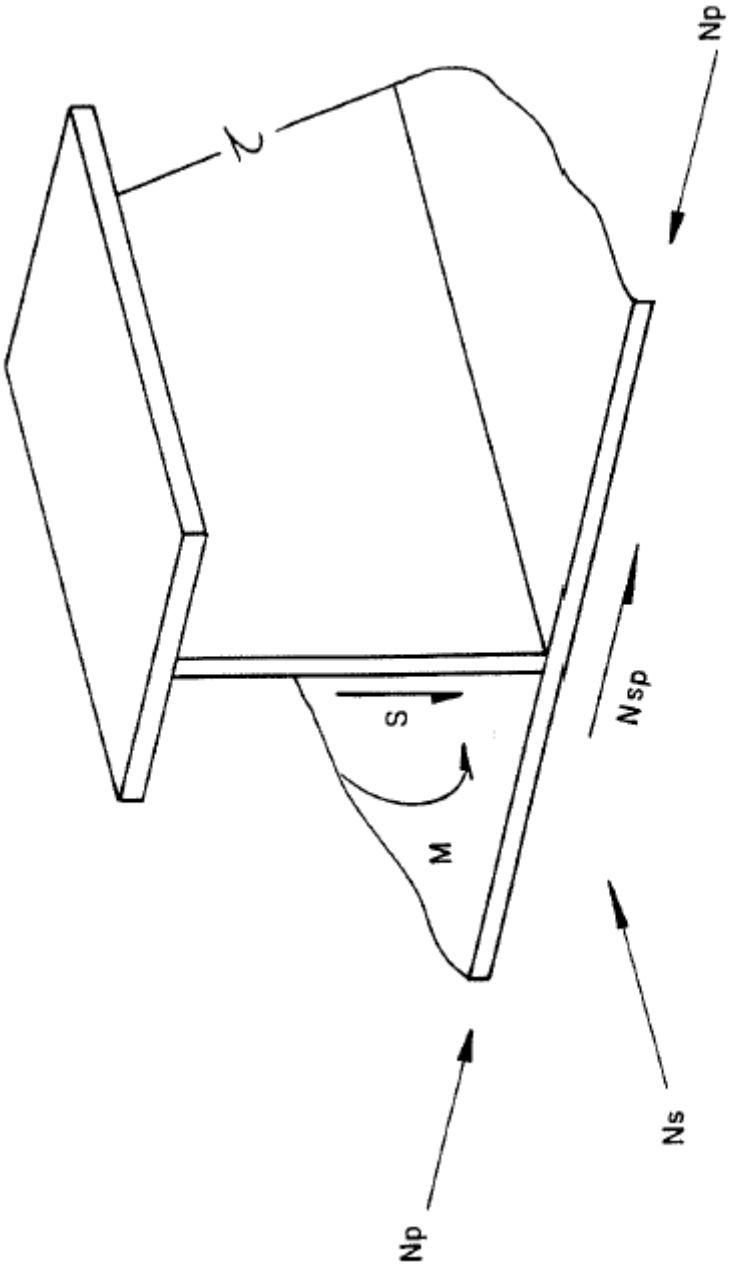

FIGURE 2.6-1: NOMENCLATURE AND DIRECTION OF LOADS

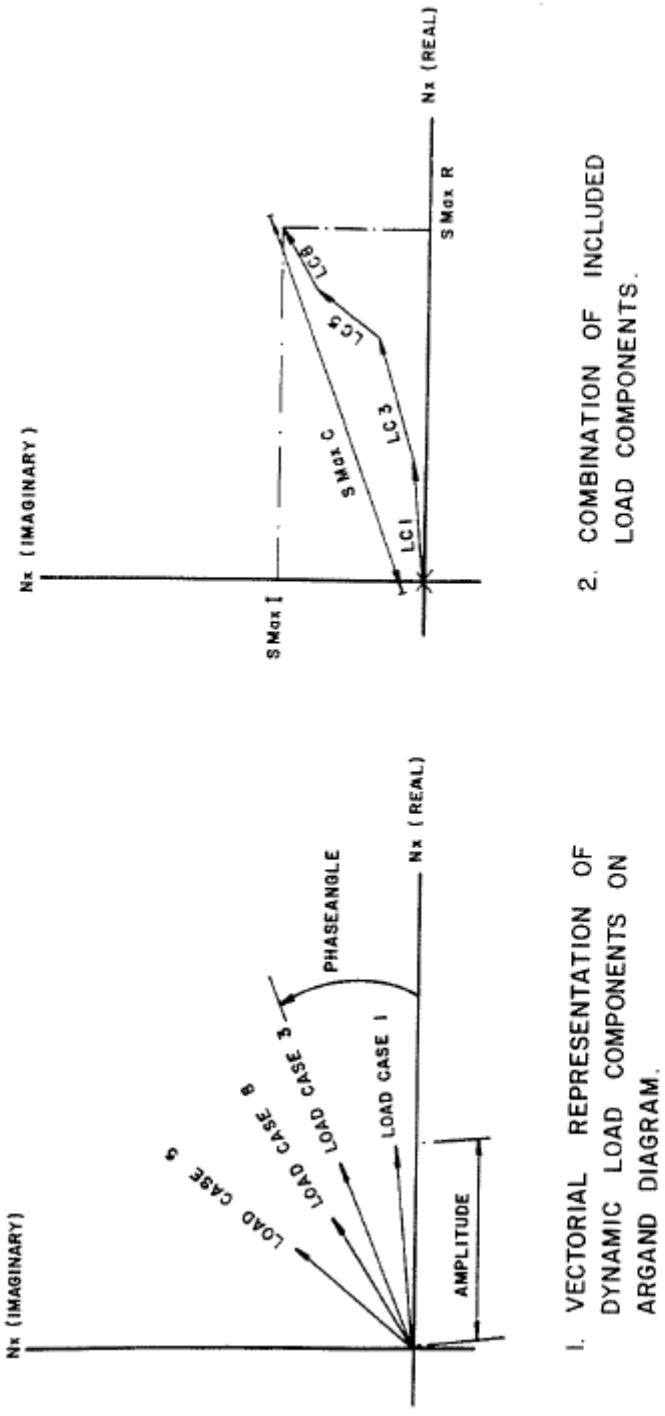

FIGURE 2.8-I:VECTORIAL REPRESENTATION AND ADDITION OF LOAD CASES

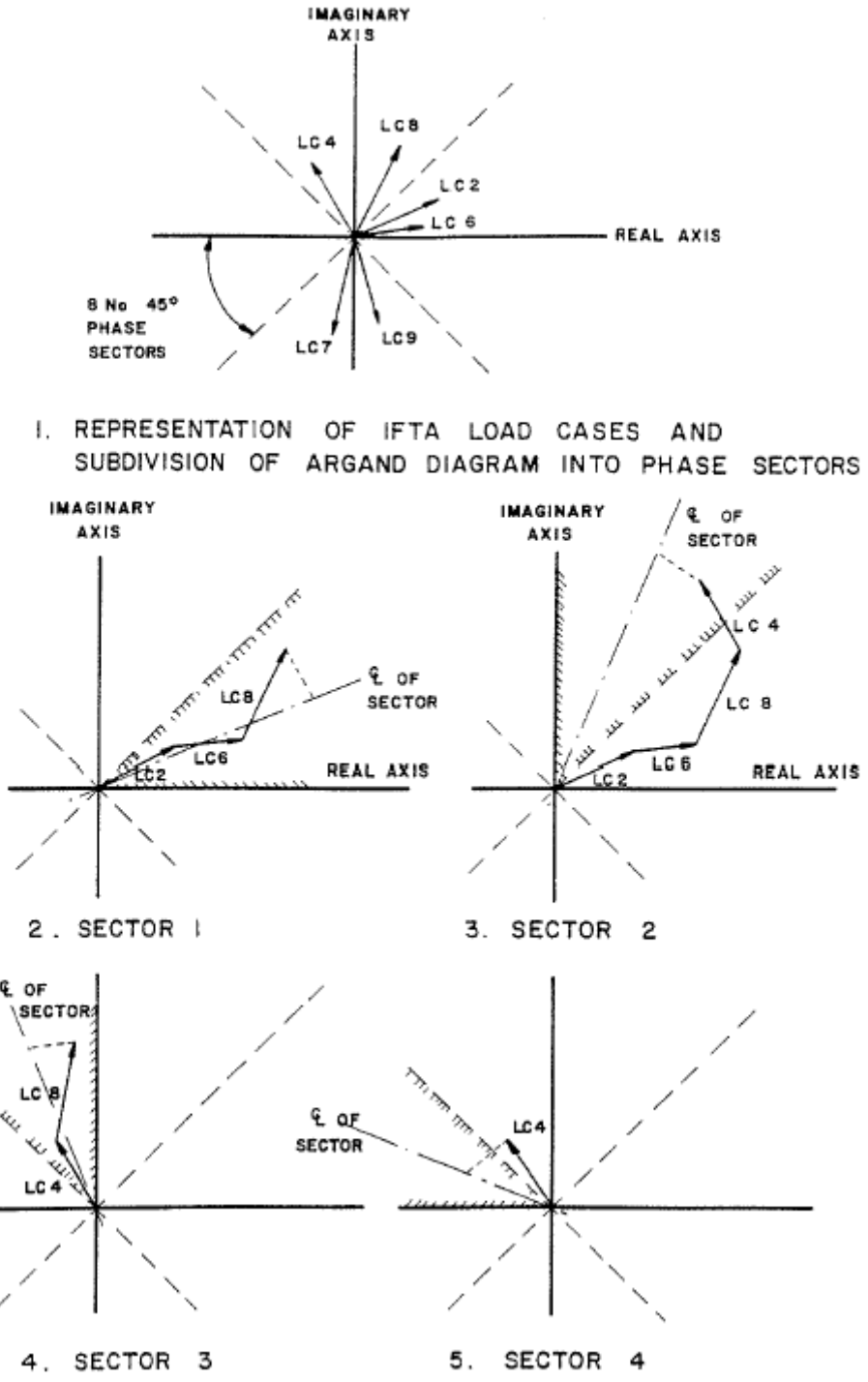

FIGURE 2.8-2: SELECTION OF IFTA CASES USING PHASE SECTORS

3 RUNNING THE PROGRAM

3.1 INTRODUCTION

PANEL-ENVELOPE operates by taking data from a text file (called the *data file)* and writing results to an *output file.*

All PANEL programs contain a command line interpreter so that input, output and other file names can be entered after the program name as a single command on all machine types (e.g. `program name filel file2...'). Data items on the command line must be specified in the following order:

1) data file name and location;

2) output file and location;

The data file name must always be specified, although it need not be given an extension if it is '.dat' (or '.DAT' on machines that are not case specific or require upper case).

Other file names are optional. If not given the last specified file name on the command line is used as a basis with a new extension defined by the program. The following default extensions are given to file types:

– output files are '.out' or '.OUT';

If the name specified for the output file corresponds to an existing file, then the original file will be overwritten

3.2 CHANGED INPUT STREAMS

All PANEL programs feature a CHANGE-INPUT-STREAM command that allows data input to be redirected to another input file on another unit or stream This is achieved by specifying in the data the unit number and file name to be used for future data input. Input may be redirected as required to other files or returned to an original file as required. This is a useful facility that allows repetitive data to be located in separate files and accessed when needed from several different runs.

Refer to the CHANGE-INPUT-STREAM command in Section 5.0 for more details.

PANEL-ENVELOPE also permits envelope data to be input from other files using the READ-INCLUSION-DATA command. This is similar in execution to CHANGE-INPUT-STREAM except that data input returns to the original file when the envelope has been read. Again, refer to Section 5.0 for more details.

3.3 INPUT AND OUTPUT CHANNELS

Several units, streams or channels are used by the program for input/output. These are listed here as they should not be used for CHANGE-INPUT-STREAM or READ-

INCLUSIONDATA input file redirection:

– Unit 5 data input

– Unit 6 main output

– Units 1 and 99 screen display (on some computers)

When an FE package is used to provide stress and geometry data, it may use additional units. Refer to the appropriate appendix for details.

The user should avoid redirecting input to any of the above unit numbers.

3.4 BATCH FILES

A convenient method of running the program is to create a batch file that includes the necessary instructions for program execution, and perhaps echoes back information on the program version and data files that are in use.

A sample batch file is given below. This example includes echoing of data to the screen, checking to see if a plot file is specified and running the program as required. Output and summary file extensions are set to be *.LIS* and *.SUM.*

No directory path to the executable is specified; the batch file assumes that the executable is located in the default installation directory C:\Program Files\ANSYS Inc\vvvv\asas\bin\win32 (where 'vvvv' is the version number), or that the directory is included in the path. See the ANSYS Installation Guide for more details.

```
@ECHO OFF
ECHO
ECHO Running PANEL-ENVELOPE
ECHO.
ECHO Data file = %1.DAT
ECHO Results file = %1.LIS
ECHO
PEAS %1 %1.LIS
:END ECHO
ECHO Problem Complete
ECHO
ECHO ON
```

If this file were called 'ENVELOPE.BAT' and were located on the path, then a run using 'EXAMPLE.DAT' as input would be started as follows:

> ENVEI.OPE EXAMPLE

4 DATA PREPARATION

4.1 INTRODUCTION

Input data for the PANEL-ENVELOPE program can be conveniently sub-divided into two types:

CONTROL DATA - used to control the execution of the program, file handling, data values, describe the FE model, select results, etc.;

INCLUSION DATA - used to define the logic by which the analysis load cases are combined to form a single envelope.

Control data is initially read from the file assigned to unit 5. This unit will normally be assigned to a physical file. This input may subsequently be redirected to other physical files using a CHANGE-INPUT-STREAM command. Refer to the CHANGE-INPUT-STREAM command for more details.

When a READ-INCLUSION-DATA command is encountered, the program reads in a batch of inclusion data defining a single envelope. This envelope will remain current until a further READ-INCLUSION-DATA command causes another envelope to be read in. Inclusion data may be stored in a separate file or in the control data file. The stream number on the READ-INCLUSION-DATA command determines where the information is to be read from. Refer to READ-INCLUSION-DATA command for more details.

4.2 UNITS

Several commands require the input of angles, which should be in degrees. Only the WEB-DEPTH and F-E-STIFFENER-SPACING commands require values to be input in specific units. In these commands, the value should be input in the same analysis units of length as were used in the original FE analysis.

PANEL-ENVELOPE follows the same units as the FE analysis that it is being used to post-process. Envelopes will be stored in these units, if so required. Facilities exist in PANEL-CHECK to be able to convert these units to those required by the code checks, if this is necessary.

4.3 SIGN CONVENTION AND AXES SYSTEM

PANEL-ENVELOPE maintains the sign convention for tension and compression that is used in the FE program to which it is interfaced. FE plate stresses and beam loads are converted to PANEL loads using the calculations described in Appendix C.

Note that this may lead to a load sign convention that is at variance with PANEL-CHECK, which assumes compression-positive, tension-negative. Facilities exist in PANEL-CHECK to correct this difference and nothing need be done in PANEL-ENVELOPE.

Consideration should be given to the FE model stress axis systems, however, as these will need to be defined relative to the stiffener and plate before PANEL-ENVELOPE can correctly extract stresses.

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Figure 2.6-1 illustrates the loads per unit width produced by PANEL-ENVELOPE. Subscripts 's' and 'p' refer to stiffener and perpendicular directions. Initially, PANEL-ENVELOPE assumes the default orientation of the FE model plate stresses in the stiffener direction. The ROTATE command can be used to change this. A similar facility exists for web stresses if the stiffener web is modelled using plate elements. Refer to the FE system appendix for details of the default plate axes.

Where the stiffener is modelled using coplanar or offset beams, the beams may be orientated so that either of the beam bending axes is in the plane of the plate. PANEL-ENVELOPE assumes by default which of these axes is coplanar, but allows the user to change this default using the BEAM command. Refer to the FE system appendix for details of the default beam axes per element type.

4.4 FINITE ELEMENT SYSTEM DATA

The control data file on unit 5 may need to start with a preliminary or run control deck (which may comprise as little as one line), to provide data about the finite element system in use and to describe the model or superelement to be processed. Such data is dependent on the FE system being used and is described in the appropriate appendix.

4.5 FORMAT OF CONTROL DATA INSTRUCTIONS

Each instruction consists of a keyword, usually followed by additional data (which may be numeric or text). Each instruction starts on a new line, and the items of data are separated from the instruction keyword and from each other by blank spaces.

Each instruction line must be eighty characters or less in length, including embedded blank characters. For some instructions (which require substantial amounts of data), continuation lines may be used as described in Section 4.8.

4.6 ABBREVIATION OF CONTROL DATA INSTRUCTIONS

Most of the control data instruction keywords are quite long, generally comprising several words separated by dashes, such as DATA-CHECK-ONLY. Although it is recommended that the instruction be entered in full (as this renders most data files reasonably legible without extra comments), the keyword may be abbreviated subject to certain conditions. These are:

- the first letter, all dashes, and the letters immediately following dashes must be included;
- the remaining letters must be in the correct order, but any can be omitted;
- the resulting abbreviation must not be ambiguous, in that two different instructions could both be abbreviated in the same way (for example, SE is not an acceptable abbreviation for SELECT because it is also a possible abbreviation of SWEEP). This restriction of non-ambiguity extends to all instructions in PANEL-ENVELOPE and PANEL-CHECK regardless of which programs are actually installed.

Keywords in the data following an instruction keyword may also be abbreviated subject to the same rules, provided that the abbreviation is not ambiguous with respect to any other keyword that could be used with the particular instruction.

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If an ambiguous instruction is supplied in the input data, PANEL-ENVELOPE will print a warning and arbitrarily choose which instruction to execute.

4.7 COMMENT LINES

Comment lines may be included in the input data file. These are denoted by an exclamation mark '!' in column one of the line. All text following the exclamation mark may be echoed to the output file, but is otherwise ignored.

It is recommended that comment lines are used liberally to indicate, for example, the source of the input data, assumptions that are being made, etc., as they prove invaluable when it is necessary to rerun an old analysis.

4.8 CONTINUATION LINES

There is, as described above, a limit of eighty characters for any line of data. Some instructions require more data than can easily be fitted within this limit and so allow the use of continuation lines.

A continuation line is denoted by a plus '+' character in the first column of the line. Comment lines may be included before each continuation line. Individual data fields may not be split over two separate lines, so, for example;

```
INSTRUCTION
12 +34
```

would be interpreted as INSTRUCTION 12 34 and not as INSTRUCTION 1234.

Where continuation lines are allowed, this is clearly demonstrated in the description of the command.

4.9 STORAGE OF ENVELOPES

The PANEL suite uses a keyed filing system for storage of envelopes on backing file by the PANEL-ENVELOPE program. This keyed filing system is a flexible system that allows the user full control over the storage of results and later retrieval by PANEL-CHECK. However, due to its flexibility, the system requires careful explanation to fully describe its capabilities. That explanation is provided here.

Each envelope produced by PANEL-ENVELOPE may be stored on backing file for subsequent access by PANEL-CHECK. The WRITE option is provided to enable this storage. Three types of envelope may be produced, individual, class and global. Individual envelopes will be produced per node in a set and one class envelope will be produced per class over an entire set. Class envelopes are distinguished by a node number of zero. Global envelopes created by the BEGIN-ENVELOPE/FINISH-ENVELOPE instructions may also be stored and are identified by set and node numbers of zero.

Each envelope to be stored by the program is allocated a 'key' so that it can be recalled directly by PANEL-CHECK. Instead of the user specifying this key directly, PANEL-ENVELOPE will calculate the key internally, given a user-specified key definition. The

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same definition will normally be provided in PANEL-CHECK to subsequently access these stored envelopes.

A key definition consists of a set of 'fields'. Up to fifteen are currently allowed. Each field is allocated a 'symbol' and a 'range' by the KEY-FIELDS and KEY-RANGES instructions.

The symbol may be a user-defined symbol (see the NEW-SYMBOL and SYMBOL-VALUE commands) which can have a user-defined value. Alternatively, the symbol in any field may be one of the following:

NODE, GROUP, SET, CLASS, ENVELOPE

These symbols are automatically updated by the program for the given node, set, class, etc., when each envelope is stored.

The range of a field must be defined by the user and must enclose all possible values that the symbol may take. Note that the range for a NODE field must start at zero as the symbols will be given a value of zero for a class envelope. Similarly, the GROUP and SET symbols may also be zero for a global envelope, if used. For a given key definition, the maximum key that can be produced will be the product of all of the individual key ranges, i.e.,

$$MAXKEY = (max_1 - min_1 + 1)*(max_2 - min_2 + 1)*----*(max_n - min_n + 1)$$

where max and min define the ranges of each of 1 to n keys.

The actual value of a given key will depend on the current values of each of the symbols that occupy the key fields at the time that the key is evaluated (when the envelope is to be stored). This is best demonstrated by example.

Suppose a key definition comprises three key fields as follows:

Field 1:	Symbol 'CASE',	range 1 to 4
Field 2:	Symbol 'GROUP',	range 1 to 10
Field 3:	Symbol 'NODE',	range 0 to 100

CASE is a user-defined symbol, GROUP and NODE are reserved symbols. The maximum key value (maximum envelopes that can be stored) is given by:

MAXKEY = (4 - 1 + 1) * (10 - 1 + 1) * (100 - 0 + 1) = 4040

Suppose the symbol values are as follows for the storage of a particular load case, group and node:

CASE = 2, GROUP = 3, NODE = 35

The key evaluation for this data would be as follows:

KEY = (35-0) + (3-1)*(100-1+1) + (2-1)*(100-0+1)*(10-1+1)
= 35 + 202 + 1010
= 1247

It is clear that there is therefore one unique key value for each combination symbol value as long as each value stays within the specified range.

The following should be noted:

- once a keyed filing system is defined, it may not be changed without the risk of overwriting previously stored envelopes, so care should be taken to ensure that the keying system is correctly defined at the start (particularly that the ranges are large enough for all eventualities);
- the keyed filing system should therefore generally be the same between different PANEL-ENVELOPE runs on the same structure;
- the reserved symbols are of great use in setting keys for all nodes across a set, all sets, etc., and should be included in the key definition where possible. The above example is a very simple use of this;
- the user-defined symbols allow other parameters to be used to govern keys, such as load case number, superelement number, etc.;
- the key system defined in PANEL-ENVELOPE should generally be the same as that defined in PANEL-CHECK to allow the required envelopes to be recovered by using the same key calculation;
- it is possible, however, to change key structures as long as care is taken. In particular, it is possible to use a single field key to allow a key to be defined directly via the SYMBOL-VALUE command. Experienced users may attempt this.

4.10 DESCRIPTION OF INCLUSION DATA DECK

An inclusion data deck is expected when a READ-INCLUSION-DATA command is encountered in the control data. The deck may be present in the control data file, or may occupy a separate file on a specified stream. Refer to the READ-INCLUSION-DATA command for more details.

The inclusion data deck must have the following layout:

```
ENVELOPE   number title
STATIC
-----------   static inclusion instructions

DYNAMIC

-----------   dynamic inclusion instructions

COMBINED

-----------   combined inclusion instructions

END
```

Each sub-deck (STATIC, DYNAMIC, COMBINED) contains inclusion data commands appropriate to that load type. Refer to Sections 2.7 to 2.9 for the significance of each sub-deck. Unlike the control data instructions no inclusion data commands may be abbreviated in any way.

4.11 LOAD CASE IDENTIFICATION

The IFTA, INCL, LOAD, REVE and WITH inclusion data commands all require that a 'case' parameter be specified to identify specific load cases to be combined and selected to foil envelopes. This numeric case parameter is used to identify load cases in the original FE analysis. Static load cases are always identified by a single load case identifier. In these cases, the 'phase' parameter should be zero.

Dynamic cases are more difficult to handle. There are three basic methods of identifying harmonic data. The method to use depends on the FE system in use and the user should refer to the appropriate appendix. The following are available:

– on systems that produce harmonic stresses as amplitude and phase, the load case number of the amplitude case should be specified as 'case' and the phase angle should be specified as 'phase';

– on systems that store harmonic loads as separate real and imaginary load cases, both load case identifiers should be coded into a single identifier in the 'case' field. If the load cases are referred to numerically, then the 'case' parameter should be as follows:

  Real case * 100,000 + Imaginary Case;

– on systems that store harmonic loads as a single, complex load case, only that load case identifier needs to be given in the 'case' field.

The second and third load types may be converted from complex to amplitude/phase format as follows:

amplitude = SQRT (Real*Real + Imag*Imag)
phase = ATAN (Imag/Real)

For load types two and three, it is possible to specify a non-zero 'phase' parameter The phase angle is taken as a phase shift and is added to the phase angle calculated as above.

Refer to the appendix for the FE system in use for any special formats for the load case identifier.

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5 COMMAND DATA COMMANDS

The following pages describe the commands available within the control data file for PANEL-ENVELOPE. Commands are presented on individual pages, in alphabetical order.

The following convention is used to describe the instruction in the Syntax line:

– keywords are presented in capital letters;

– other text/numerical data to be provided by the user is represented by lower case words; optional data is enclosed in brackets, '( )';

– choices of keywords or data are separated by slashes, '/';

– lists of data are indicated thus '----'. The logic of the repetition list is often self-explanatory but may be augmented in the command description.

A summary of the commands available is presented in Appendix A. The summary is useful to remind experienced users of the instruction formats.

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Command : ALL

Syntax : ALL

Example : ALL

Description:

Selects all nodes in a set for future processing. When a DO-CHECKS instruction is encountered, the program will scan the currently selected plate element set (SET or GROUP) and identify and classify (see Section 2.5) all nodes on the plate. If enveloping is enabled (ENVELOPE ON), the program will proceed to evaluate and store envelopes at these nodes.

This command is overwritten by the SAMPLE, SELECT and CLEAR-SELECT commands which allow other methods of node selection.

ALL is synonymous with SWEEP, and either may be used in PANEL-ENVELOPE.

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Command : AVERAGE

Syntax : AVERAGE newnod class envelope (group)

Example : AVERAGE 201 3 6
AVERAGE 1023 1 5 101

Description:

The AVERAGE command may be used in combination with the CLEAR-SELECT and SELECT commands to produce averaged envelopes over a number of nodes and to store these (if WRITE is ON) back onto the database for access by PANEL-CHECK.

The 'newnod' parameter is the number by which the new node will be known. It will be stored, if required, with the associated 'class' and 'group'. Only the 'envelope' specified will be averaged by this command.

AVERAGE acts immediately and does not need a DO-CHECKS command. It is intended that AVERAGE be used at the end of a standard PANEL-ENVELOPE run, or in subsequent runs to average stresses over a number of nodes for use, perhaps, as reference nodes in PANEL-CHECK.

The user should be careful of averaging over classes. Whilst this is quite possible, care should be taken when averaging plate and stiffener classes (say 1 and 2) as they have a different number of stresses.

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Command : BEAM

Syntax : BEAM (DEFAULT/ROTATED)

Examples : BEAM
BEAM ROTATED

Description:

The BEAM instruction may be used to specify the orientation of bar or beam elements relative to the plate. For each bar or beam element type, a default axis is assumed to lie in the plane of the plate. The elements may be rotated to bring this axis perpendicular to the plate by using the ROTATED option. Default axes for each valid element type may be found in the appendices appropriate to the FE analysis system in use.

The orientation flag need not be specified. If omitted, or if the command is not given, DEFAULT is assumed.

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Command : BEGIN-ENVELOPE

Syntax : BEGIN-ENVELOPE number (title)

Example : BEGIN-ENVELOPE 1 ENVELOPE OVER SETS 3, 4 AND 5

Description:

The BEGIN-ENVELOPE command starts the creation of global envelopes which may extend over several different inclusion data sets, over several different groups of elements or over several different panel sets. These envelopes are in addition to the individual and class envelopes that are normally created. An envelope number must be given and a title may be associated with these envelopes. While global envelopes are active, any DO-CHECKS instructions will cause the envelope to be extended by the new class envelopes created.

A FINISH-ENVELOPE command is available to end this overall enveloping and to print the latest envelope. Intermediate printing may be achieved via the PRINT-ENVELOPE instruction. Overall envelopes are not stored when a WRITE ON command is issued.

Overall envelopes are distinguished by GROUP and NODE symbols of zero when the key is evaluated.

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Command : CHANGE-INPUT-STREAM

Syntax : CHANGE-INPUT-STREAM (stream (filename))

Example : CHANGE-INPUT-STREAM 25

Description:

When a CHANGE-INPUT-STREAM command is issued, input of data immediately switches to the stream number specified. This stream number should have either been assigned to a file by an operating system command before running the PANEL-ENVELOPE, or else a filename should be specified as part of the instruction.

Input starts by default on stream 5. When a CHANGE-INPUT-STREAM command is encountered, input switches to the new file associated with the new stream. Input may be returned to the original file with a further CHANGE-INPUT-STREAM command with no argument given or with a stream number of 5. Processing will recommence at the line after the original CHANGE-INPUT-STREAM instruction.

The above procedure allows input from two or more files. At least one of these files may be a 'reference file' common to a number of different runs of PANEL-ENVELOPE. The data files for each of these runs will contain a CHANGE-INPUT-STREAM command to switch input to the reference file, which will end with a CHANGE-INPUT-STREAM command (with no argument) to return control to the original input file.

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Command : CHART

Syntax : CHART (NONE/OFF/ON/ONA)

Examples : CHART NONE
CHART OFF
CHART ON
CHART ONA

Description:

The CHART command controls the level of output of individual (nodal) envelopes from the PANEL-ENVELOPE program and may take the following values:

NONE : produces no output for individual envelopes, but class envelopes are still printed;

OFF : only final numerical envelopes are printed per location. This option produces one page of output per location and one page per class;

ON : in addition to the numerical envelope values, the program also produces a list of load case selection showing how each envelope is formed. Only load cases selected for the envelope are included. WITH cases are not tabulated, as they follow the inclusion logic of the command preceding;

ONA : a special form of ON tabulating all load inclusion cases whether they are part of the envelope or not. Output is again per location or class and contains the numerical output. WITH cases are not included.

The default print level is OFF, which is adequate for most purposes. The ONA and ON levels should be used with care as the output can become very lengthy, particularly if a large amount of inclusion data or a large number of nodes are selected.

Note that the CHART command does not control output to the backing files. The WRITE command is provided for this purpose.

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Command : CLEAR-SELECT

Syntax : CLEAR-SELECT class nodel (node2 ----)

Examples : CLEAR-SELECT 3 21
CLEAR-SELECT 1 10 11 12 13 14

Description:

The CLEAR-SELECT command operates in a similar way to the SELECT command, except that all previous selections of nodes and classes are cleared before the new selection is added. The command may, for example, be used when a new group has been selected. The action will be to clear the selection of nodes for the previous group, and start selection for the new group. The following example data file illustrates this:

```
:
CLEAR-SELECT  1  1  2  3
SELECT  2  10  11  12
:
DO-CHECKS
        (Nodes 1,  2,  3,  10,  11,  12 checked)
:
CLEAR-SELECT  1  101  102  103  104
SELECT  2  110  111
:
DO-CHECKS
        (Nodes 101,  102,  103,  104,  110,  111 checked)
:
```

Note that all previous selections of nodes for all classes are cleared by this command, not just the selection for the given class.

Node selection is cancelled by the ALL, SAMPLE and SWEEP commands, which allow alternative methods of node selection.

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Command : DATA-CHECK-ONLY

Syntax : DATA-CHECK-ONLY

Example : DATA-CHECK-ONLY

Description:

The DATA-CHECK-ONLY command is identical to the ENVELOPE OFF instruction and disables enveloping of stresses when a DO-CHECKS instruction is encountered. Only nodal selection, classification and sampling will be performed while this option is selected.

Enveloping may be switched back on by the ENVELOPE ON command. The default on program start-up is to perform enveloping.

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Command : DEBUG

Syntax : DEBUG level/OFF (routine (values ----))

Examples :
```
DEBUG  OFF
DEBUG  OFF  DOCHKS
DEBUG  2      ENVEL
DEBUG  99  SRINS 10.1  10.2  10.3
```

Description:

The DEBUG command may be used to force the program to monitor progress through selected routines. It is only of use to users who are familiar with the internal operation of the program and should be used with care, as it can produce a considerable amount of output.

The debug level has different effects depending on the routine to be checked.

A debug level over ninety-nine forces the routine to overwrite certain routine arguments with debug data values specified on the end of the line. DEBUG OFF cancels all debugging for all routines. DEBUG OFF with a routine name cancels debugging for that routine.

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Command : DO-CHECKS

Syntax : DO-CHECKS

Example : DO-CHECKS

Description:

The DO-CHECKS command instructs the program to start calculations using the current data defined by previous instructions. If SWEEP, ALL or SAMPLE have been specified, the program will scan the panel and automatically classify/select nodes for checking. If a data error exists, or if DATA-CHECK-ONLY or ENVELOPE OFF commands have been given, processing will not proceed further. However, if an ENVELOPE ON instruction has been issued and all data is acceptable, the program will start to perform enveloping using the currently selected nodes/classes and inclusion data. If database writing is enabled (via the WRITE command), these envelopes will then be output to backing file for subsequent access by PANEL-CHECK or other programs.

When processing of a DO-CHECKS command is complete, the program returns to input further commands from the current input stream. Only an END or STOP command will terminate the program.

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Command : ECHO

Syntax : ECHO (ON/OFF)

Examples : ECHO
ECHO OFF

Description:

The ECHO command controls echo of input commands to the output stream or file. When this command is ON, each input instruction is attributed a line number and printed as it is encountered. Inclusion data echo is also controlled by this command.

The default for ECHO is OFF. The LIST-INPUT-DATA and LIST-INCLUSIONDATA commands may be used to control the output of interpreted data in addition to the simple command echo.

ECHO with no parameters is taken as ECHO ON.

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Command : EFFECTIVE-WIDTH-FACTORS

Syntax : EFFECTIVE-WIDTH-FACTORS ewfmid (ewfend)

Examples : EFFECTIVE-WIDTH-FACTORS 0.900
EFFECTIVE-WIDTH-FACTORS 1.000 0.500

Description:

The EFFECTIVE-WIDTH-FACTORS command is used indirectly to specify the effective width of plate used to calculate section bending properties when the stiffeners are modelled with either offset beams or with plate/shell elements for the webs, and rod/bar/beam elements for the flange. The effective width factors are multiplying factors on the stiffener spacing (see F-E-STIFFENER-SPACING command). Details of how these parameters are used may be found in Appendix C.

If two effective width factors are given, the first applies to mid-span locations and the second to stiffener ends. If a node is of class 2, the end factor is used, but if the node is of class 4 or 5, the mid-span value is taken.

If the end value is not given, it defaults to the mid-span value. If no EFFECTIVE-WIDTH-FACTORS command is issued, default effective width factors of 1.0 are assumed at both locations.

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Command : END

Syntax : END

Example : END

Description:

The END command is identical to the STOP command and has the action of terminating the current run (even if further data exists in the input file), closing all files and returning to the operating system.

Command : ENVELOPE

Syntax : ENVELOPE (ON/OFF)

Example : ENVELOPE
ENVELOPE OFF

Description:

The ENVELOPE command controls whether enveloping is to be performed or not when a DO-CHECKS instruction is encountered. If enveloping is switched OFF, only a data check will be performed and the command is identical to DATA-CHECK-ONLY. If enveloping is switched ON, enveloping will be performed after location selection and classification only if no errors have been encountered thus far in the data.

The default at start-up is to enable enveloping. ENVELOPE with no parameters is taken as ENVELOPE ON.

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Command : F-E-STIFFENER-SPACING

Syntax : F-E-STIFFENER-SPACING spacing

Example : F-E-STIFFENER-SPACING 1.500

Description:

The F-E-STIFFENER-SPACING instruction may be used to specify an effective spacing to be used to evaluate forces and stresses per unit width prior to enveloping. Appropriate calculations are included in Appendix C.

The units of the stiffener spacing should be in the same units as the length units used in the analysis. The default spacing is 1.0 and the input value is checked to ensure that it is reasonable.

Note that this spacing should be the **as modelled** stiffener spacing in the FE analysis. This may be different from the true spacing in the actual structure. Spacing is used to derive the loads per unit width and not for checking of the Section. A separate, different, actual spacing may be provided in PANEL-CHECK for checking purposes. This allows stiffeners to be modelled as 'lumped' together at more than the true spacing, yet still be analysed successfully in PANEL-CHECK.

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Command : FINISH-ENVELOPE

Syntax : FINISH-ENVELOPE

Example : FINISH-ENVELOPE

Description:

The FINISH-ENVELOPE instruction marks the end of an envelope over several different classes or sets. The envelope must previously have been started using a BEGIN-ENVELOPE instruction. The effect of the command will be to output the envelope created over all classes processed since the BEGIN-ENVELOPE instruction.

Global envelopes will be printed (if CHECK options dictate printing) and stored to disk (if WRITE ON has been specified). Refer to Section 4.9 for details of envelope storage.

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Command : **FLANGE-NODE**

Syntax : FLANGE-NODE pinode flnodel (flnode2)

Example : FLANGE-NODE 21 121
FLANGE-NODE 171 175 167

Description:

The FLANGE-NODE command may be used to overwrite the automatic search routines that scan nodes in the web to return the flange node(s) that correspond(s) to a given plate node. This facility is therefore only available when the stiffener modelling method is WEB-PLATE.

PANEL-ENVELOPE uses a simple topological search based on connectivity. Basically, it searches from node to node across the web, locating and listing nodes that are adjacent to the current node, but which are not on the currently adjacent elements, nor on the plate. When no more free nodes can be traced, the last node is assumed to lie on the flange. This approach is perfectly acceptable for regular web element meshes, but may not be possible, or may give incorrect results when applied to irregular meshes. The FLANGE-NODE command is then available to prevent this search taking place by direct user input of the plate and corresponding flange nodes.

The FLANGE-NODE command is particularly useful (and necessary) when a double-sides stiffener has been modelled using the WEB-PLATE method. In this case, two flange-node numbers are required, one for the top stiffener and one for the bottom. Note that only one web plate group and one flange beam group should be used for both webs and flanges in this case.

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Command : GROUP

Syntax : GROUP set

Example : GROUP 12

Description:

The GROUP command allows the selection of sets or groups that have been defined in the FE analysis to contain all elements that represent the panel under consideration. The 'set' parameter defines the elements representing the plate. There is no default for a GROUP command, and at least one must be present in each run. The command is synonymous with SET. Either command may be used.

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Command : KEY-FIELDS

Syntax : KEY-FIELDS keysym1 (keysym2----)

Examples : KEY-FIELDS KEY1
KEY-FIELDS CASE GROUP NODE

Description:

The KEY-FIELDS instruction allows the definition of an index system for filing of envelope results. Up to fifteen KEY-FIELDS may be defined. These fields may be previously-defined symbols (via NEW-SYMBOL), or may be any of the following reserved symbols:

ENVELOPE	-	envelope number
NODE	-	node number (zero for set and global envelopes)
GROUP	-	group/set number (zero for global envelopes)
SET	-	group/set number (zero for global envelopes)
CLASS	-	class number

For the keyed filing system to be fully defined, a set of ranges must be defined for each field on this card. The KEY-RANGES card is provided for this purpose and it is normal that a KEY-RANGES command will immediately follow KEY-FIELDS.

A full description of the keyed filing system in use by PANEL-ENVELOPE is given in Section 4.9.

Note that there is no default for this command. It must be present in the input data if WRITE ON is used to enable output to backing file.

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Command : KEY-RANGES

Syntax : KEY-RANGES min1 max1 (min2 max2 (----))

Examples : KEY-RANGES 1 100
KEY-RANGES 1 4 1 50 0 1000

Description:

The KEY-RANGES command allows numerical ranges to be assigned to the fields created by a KEY-FIELDS instruction. Together, these two commands are used to define a keyed filing system for the storage of PANEL-ENVELOPE results.

Ranges are specified by minimum and maximum values for each field. The number and order of the ranges must correspond to those given on a KEY-FIELDS instruction. A KEY-FIELDS instruction must precede KEY-RANGES.

Note that if the reserved symbols NODE, SET or GROUP are used on a KEY-FIELDS instruction, then the corresponding ranges should start at zero, to allow storage of set and global envelopes as well as node envelopes. The NODE range MUST always start at zero.

A full description of the keyed filing system is included in Section 4.9 of this manual.

The default range is zero to zero for each field, giving a trivial maximum key of one. In general, therefore, a KEY-RANGES card is always required if a KEY-FIELDS is specified.

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Command : LIST-INCLUSION-DATA

Syntax : LIST-INCLUSION-DATA (ON/OFF)

Examples : LIST-INCLUSION-DATA
LIST-INCLUSION-DATA OFF

Description:

The LIST-INCLUSION-DATA command controls the printing of interpreted inclusion data used to define an envelope. The output produced is a list of expanded inclusion data after the deck has been read in. The printout produced by this command is rather more detailed than the simple data echo produced by the ECHO command.

The default for LIST-INCLUSION-DATA is ON. A similar command controls listing of control data.

LIST-INCLUSION-DATA with no parameters is taken as LIST-INCLUSION-DATA ON.

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Command : LIST-INPUT-DATA

Syntax : LIST-INPUT-DATA (ON/OFF)

Examples : LIST-INPUT-DATA
LIST-INPUT-DATA OFF

Description:

The LIST-INPUT-DATA instruction allows selective printing of interpreted input data as commands are read in. The printout produced by this command is rather more detailed than the simple data echo produced by the ECHO command.

The default for LIST-INPUT-DATA is ON. A similar command controls listing of inclusion data.

LIST-INPUT-DATA with no parameters is taken as LIST-INPUT-DATA ON.

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Command : MAXIMUM-ERRORS

Syntax : MAXIMUM-ERRORS maxerr

Example : MAXIMUM-ERRORS 10

Description:

The MAXIMUM-ERRORS command is used to control the number of input errors that are allowed before further efforts to process input data are abandoned. By default, the maximum number of errors is set to zero, so that the program will stop at the first error.

This command allows input data with errors to be processed up to an acceptable level of error before input is terminated. It does not control enveloping. If there are any input errors when a DO-CHECKS instruction is encountered, enveloping of results will be abandoned but further input data will be processed up to the maximum error count.

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Command : NEW-SYMBOL

Syntax : NEW-SYMBOL symbol (value)

Examples : NEW-SYMBOL KEY1
NEW-SYMBOL KEY2 31

Description:

The NEW-SYMBOL command is used to create symbols for use in the KEY-FIELDS instruction to define the keyed filing system. Numerical values may optionally be defined by this command or by the SYMBOL-VALUE instruction. The default value for a symbol is zero.

The following symbols are reserved and should not be used:

ENVELOPE, NODE, GROUP, SET, CLASS

Apart from the reserved symbols, the NEW-SYMBOL command must be used to define a symbol before it can be referenced by a KEY-FIELDS instruction.

Section 4.9 contains a full description of the PANEL keyed filing system.

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Command : NUMBER-OF-PHASES

Syntax : NUMBER-OF-PHASES sectors

Example : NUMBER-OF-PHASES 4

Description:

The NUMBER-OF-PHASES command allows the selection of the number of segments on an Argand diagram within which enveloping of dynamic load cases will occur. The number of phases should be an even integer value between 2 and 8, with 8 being the default if this card is not specified.

The number of phases will affect the accuracy and cost of the enveloping of dynamic and combined envelopes. It is recommended that odd values are not used as the dynamic enveloping process is more efficient when symmetry of the Argand diagram may be assumed.

Section 2.8 describes the use of phase sectors for enveloping of dynamic results and Section 2.10 gives some idea of the relative accuracy of different numbers of phase segments.

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Command : PHASE-SIGN-CONVENTION

Syntax : PHASE-SIGN-CONVENTION LAG/LEAD POS/NEG/+/-

Examples : PHASE-SIGN-CONVENTION LAG POS
PHASE-SIGN-CONVENTION LEAD +

Description:

The PHASE-SIGN-CONVENTION allows definition of the sign convention to be assumed for phase information. By default, LAG is assumed to be positive and LEAD to be negative. This command affects the interpretation of the phase information input for dynamic load cases in the inclusion data deck (see Section 6.0).

Section 2.8 gives a full description of the way in which harmonic dynamic loading is handled by the PANEL suite. Section 4.11 describes the specification of dynamic load cases and associated phases.

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Command : PRINT-ENVELOPE

Syntax : PRINT-ENVELOPE

Example : PRINT-ENVELOPE

Description:

The PRINT-ENVELOPE command allows the intermediate printing of an overall envelope, started by a BEGIN-ENVELOPE instruction. The envelope will be that formed over any and all DO-CHECKS instructions since the envelope was started.

This command does not terminate the overall enveloping and subsequent DO-CHECKS instructions may cause the envelope to be extended until a FINISH-ENVELOPE command is encountered.

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Command : READ-INCLUSION-DATA

Syntax : READ-INCLUSION-DATA (stream (filename))

Examples : READ-INCLUSION-DATA
READ-INCLUSION-DATA 25

Description:

The READ-INCLUSION-DATA command is used to initiate the input of a block of inclusion data defining an envelope. Input of the inclusion data continues until an END instruction is reached. Section 6.0 gives details of the format of the inclusion data commands. Section 4.10 describes the deck itself.

If no parameter is specified for this command, it will be assumed that inclusion data is stored in the same file as the control data, starting immediately after the READ-INCLUSION-DATA command. If an integer number is given, this is assumed to be the unit number for the inclusion data file. This unit number must be assigned to a physical file in the run control for the job, or a filename should be given on the instruction. Some unit numbers are already in use by the program and should be avoided. Units 5, 6 and 51 are always used. Other units used to interface with an FE system are noted in the appendices.

When an END instruction is encountered in the inclusion data, control returns to the original control data file.

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Command : SAMPLE

Syntax : SAMPLE

Examples : SAMPLE

Description:

The SAMPLE command causes a sample of nodes in a set to be selected when a DO-CHECKS command is encountered. Nodes in the set are first classified (see Section 2.5) and are then selected for enveloping. The following classes are produced:

Class 1 – All corners
Class 2 – Nodes at ends of innermost and outermost stiffeners
Class 3 – Nodes at centre of edges
Class 4 – Nodes at centre of outer stiffener
Class 5 – Node at centre of innermost stiffener
Class 6 – Nodes on stiffened edges

This command is overwritten by the SELECT, CLEAR-SELECT, ALL or SWEEP instructions, which allow other methods of node selection.

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Command : SELECT

Syntax : SELECT class node1 (node 2 ----)

Examples : SELECT 1 323
SELECT 3 100 109 200 209

Description:

This command allows nodes to be selected by node number for enveloping when a DO-CHECKS command is encountered. The first field is the class number for the following nodes and should be an integer number from 1 to 7. Class definitions are described in Section 2.5.

Select commands are cumulative. CLEAR-SELECT should be used to cancel previous selections and start again. Refer to the CLEAR-SELECT command for more details.

Apart from the CLEAR-SELECT command, node selection is cancelled by the ALL, SWEEP and SAMPLE commands, which allow other methods of node selection.

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Command : SET

Syntax : SET set

Examples : SET 101

Description:

The SET command allows the selection of sets or groups that have been defined in the FE analysis to contain all elements that represent the panel under consideration. The 'set' parameter defines the elements representing the plate. There is no default for a SET command, and at least one must be present in each run. The command is synonymous with GROUP. Either command may be used.

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Command : STANDARD

Syntax : STANDARD

Examples : STANDARD

Description:

The STANDARD command causes the program to revert to assuming the default orientation of stiffeners which may have been changed by the ROTATE command. The standard orientation is normally along the X-axis of the plate, but depends on the FE system in use, as noted in the appendices. The command ensures that the default axis stresses are used when deriving loads in the direction of the stiffener.

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Command : STIFFENER-MODEL

Syntax : STIFFENER-MODEL motype (set1 (set2))
STIFFENER-MODEL OFFSET set1 offset

Examples : STIFFENER-MODEL SMEARED
STIFFENER-MODEL COPLANAR 1001
STIFFENER-MODEL WEB-PLATE 2001 3001
STIFFENER-MODEL OFFSET 1002 0.100

Description:

The STIFFENER-MODEL command is used to specify the method of modelling employed in the FE analysis of the stiffeners used in the stiffened steel plate structures. In addition, it is used to define the necessary beam, web and flange set numbers, and the beam offset, if required. As indicated in the example above, if the modelling type is SMEARED, no beam, web or flange set numbers are specified. If the modelling type is COPLANAR, the value 1001 specified represents the beam set number, and if the modelling type is WEB-PLATE, the values 2001 and 3001 would represent the web and flange set numbers respectively. For stiffeners modelled as OFFSET, the value 1002 represents the beam set numbers, while the value 0.100 represents (in analysis units) the offset of the beam from the plate panel.

'motype' - this parameter is used to indicate the method by which the stiffeners have been modelled in the plate.

The possible modelling types are:

SMEARED, COPLANAR, OFFSET, WEB-PLATE

'set1' - represents the beam set number when the modelling type is either COPLANAR or OFFSET, while it represents the web set number when the modelling type is WEB-PLATE

'set2' - represents the flange set number when the modelling type is WEB-PLATE;

'offset' - represents the offset of the modelled beam stiffeners from the plate panel, when the modelling type is OFFSET. Must be input in the analysis units.

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Command : STOP

Syntax : STOP

Examples : STOP

Description:

The STOP command is synonymous with END and immediately terminates the current run. Any further commands in the data file are ignored, all files are closed and control is returned to the operating system.

Command : SUBROUTINE-TRACE

Syntax : SUBROUTINE-TRACE (ON/OFF)

Examples : SUBROUTINE-TRACE
SUBROUTINE-TRACE OFF

Description:

Like the DEBUG command, SUBROUTINE-TRACE may be used to monitor progress through the program and is intended only for users with a knowledge of the internal operations of PANEL-ENVELOPE. The list of subroutine entries and exists produced is extremely lengthy, so this command should be used with care.

SUBROUTINUE-TRACE with no parameters is taken as SUBROUTINE-TRACE ON.

Command : SWEEP

Syntax : SWEEP

Examples : SWEEP

Description:

Synonymous with ALL, the SWEEP command selects all nodes in a group or set for future processing. When a DO-CHECKS command is encountered, the program will scan the currently selected plate element set (SET or GROUP) and identify and classify (see Section 2.5) all nodes on the plate. If enveloping is enabled (ENVELOPE ON), the program will proceed to evaluate and store envelopes at these nodes.

This command is overwritten by the SAMPLE, SELECT and CLEAR-SELECT instructions, which allow other methods of node selection.

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Command : SYMBOL-VALUE

Syntax : SYMBOL-VALUE symbol value

Examples : SYMBOL-VALUE KEY1 23

Description:

The SYMBOL-VALUE command is used to allocate or reallocate values to symbols set up by NEW-SYMBOL and used by KEY-FIELDS to define part or all of the keyed filing system. The value assigned to a symbol should be within the range specified for that field via the KEY-RANGES instruction.

The following reserved symbols are automatically updated by the program and should not be assigned values by SYMBOL-VALUE:

ENVELOPE, NODE, GROUP, SET, CLASS

Section 4.9 gives a full description of the PANEL-ENVELOPE keyed filing system.

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Command : WEB-DEPTH

Syntax : WEB-DEPTH depth

Examples : WEB-DEPTH 0.550

Description:

The WEB-DEPTH command is used to specify the depth of web used in evaluating the section properties and stresses for a stiffened plate section modelled using plate elements to represent the web. The web depth is the distance from the centre-line of the flange beam to the centre-line of the plate shell elements. Details of the calculations used to derive the section properties are included in Appendix C.

By default, if no web depth is specified, a depth is calculated as the distance between a given platen node and its corresponding flange node. This depth may not be correct if the plate and flange nodes do not lie in a common section of stiffener.

The web-depth should be given in the units of length of the analysis.

Note that the web depth issued to integrate analysis stresses to give loads and should therefore be the **as modelled** web depth. This may be different from the actual web depth. Once the loads are obtained, the true section properties may be input into PANEL-CHECK for stress checking purposes.

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Command : WEB-STRESS-ORIENTATION

Syntax : WEB-STRESS-ORIENTATION angle

Examples : WEB-STRESS-ORIENTATION 90.00

Description:

This command applies only when stiffeners are modelled with a plate element for webs, and causes the web stresses to be rotated through a given angle prior to combination with plate and web flanges. The form that this combination takes is described in the appendices.

By default, it is generally assumed that the web X-axis lies in the direction of the stiffeners, although this may not be the case for some FE systems. The appropriate axis direction for the FE system in use may be found in the appendices.

The orientation angle is always in degrees.

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Command : WRITE

Syntax : WRITE (ON/OFF)

Examples : WRITE
WRITE OFF

Description:

The WRITE command may be used to enable and disable storage of envelopes on the database for subsequent access by PANEL-CHECK or other programs.

By default, storage of envelopes is disabled at program start up.

WRITE or WRITE ON enables storage of envelopes for future DO-CHECKS instructions. WRITE OFF disables this storage again.

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6 INCLUSION DATA COMMANDS

The following pages describe the commands available within an inclusion data deck for PANEL-ENVELOPE. Commands are presented on individual pages, in alphabetical order.

The same convention is used for syntax as was used for control data, namely:

– keywords are presented in capital letters;

– other text/numerical data is represented by lower case words;

– optional data is enclosed in brackets, '( )';

– choices of keywords or data are separated by slashes, '/';

– lists of data are indicated thus '----'. The logic of the repetition list is often self-explanatory but may be augmented in the command description.

A summary of the commands available is presented in Appendix B. The summary is useful to remind experienced users of the instruction formats.

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Inclusive Command : CHOO

Syntax : CHOO S/D S/U/B minnum maxnum (text)

Examples : CHOO S U 0 10 CHOOSE 0 TO 10
CHOO D S 1 1 CHOOSE ONLY 1

Description:

The CHOOse command is used to specify a choice or selection of a certain number of the following inclusion data lines as part of the envelope. The list of following commands may only include LOAD, USE and WITH commands; all others are invalid in this context and will cause the CHOOse list to be terminated. The first following command must be a LOAD instruction and there is currently a list length limit of fifty lines.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined. Either S or D is allowed in the COMBINED section.

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command. The B flag is not permitted in the COMBINED sub deck, but may be simulated by extending the service and ultimate envelopes separately.

The 'minnum' and 'maxnum' parameters define the minimum and maximum numbers of following load cases that will be selected to extend the envelope. No less than 'minnum', and no more than 'maxnum' of the following cases will be used for each load, for each location. The following restrictions apply:

– minnum may not be less than zero;
– maxnum may not be less than minimum;
– maxnum may not be greater than the number of following load cases.

The worst of the following cases are always chosen, in the sense of those cases that extend the envelope furthest, if there are more than maxnum cases that extend the envelope, only the worst maxnum cases will be chosen. If there are between minnum and maxnum cases that extend the envelope, then only those cases will be chosen. If there are less than minnum cases that extend the envelope, then minnum cases must still be chosen. Note that this may cause the selection of cases that actually contract the envelope. If this is the case, those such cases will be multiplied by their ultimate factor to reduce the envelope by the minimum amount (see Section 2.7).

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : COMBINED

Syntax : COMBINED

Examples : COMBINED

Description:

The COMBINED command acts as a header to the combined dynamic and static sub-deck of the inclusion data. The use of the COMBINED sub-deck is described in Section 2.9 of this guide.

The COMBINED sub-deck must follow both the STATIC and DYNAMIC sub-decks. This command must always be present even if no combined inclusion lines are specified.

Inclusive Command : DEFI

Syntax : DEFI S/U/B group (text)

Examples : DEFI B 3 SUB-ENVELOPE

Description:

The DEFIne command is used to start the definition of a sub-envelope that may subsequently by USEd in the COMBINED sub-deck of the inclusion data. Definition of a sub-envelope continues until a FINIsh command is found. Definition of a sub-envelope may not straddle sub-decks within the inclusion data, but may contain any valid inclusion data except FINI, DEFI and USE.

The S/U/B (Service/Ultimate/Both) flat is included for compatibility with other commands only. It is not used by the program and may be set to any arbitrary value. The actual envelopes affected are defined by each of the constituent cards within the sub-envelop definition.

The group number is the number of the sub-envelope being defined. A maximum of ten sub-envelopes may currently be defined. A previously defined sub-envelope may be redefined using a fresh DEFFFINI construct. However, such redefinition may only be performed after the original sub-envelope has been used at least once.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : DYNAMIC

Syntax : DYNAMIC

Examples : DYNAMIC

Description:

The DYNAMIC commands acts as a header to the dynamics sub-deck of the inclusion data. The use of the dynamic deck is described in Section 2.8 of this guide.

The DYNAMIC sub-deck must follow the STATIC sub-deck and precede the COMBINED sub-deck. This command must always be present even if no dynamic inclusion lines are present.

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Inclusive Command : END

Syntax : END

Examples : END

Description:

The END command marks the end of a given inclusion data deck. Upon execution it returns the program to the input of control commands. If the inclusion data was present in the control data file, this will be the next line, but if the inclusion data was in a separate file, this will be the control file line after the READ-INCLUSION-DATA command.

The inclusion data END command should not be confused with the control data END command, which terminates a run.

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Inclusive Command : ENVELOPE

Syntax : ENVELOPE number (title)

Examples : ENVELOPE 2 STORM CONDITIONS

Description:

The ENVELOPE command defines the number and title of the envelope that will be created following the inclusion data in this inclusion deck. The ENVELOPE card must be the first card of the inclusion data deck.

The envelope number will be used in storage of the envelope vales and should be unique across different inclusion data decks.

The envelope title is optional and if given, may be up to sixty-nine characters in length.

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Inclusive Command : FINI

Syntax : FINI S/U/B group (text)

Examples : FINI B 2 FINISH 2

Description:

The FINIsh command is used to end the definition of a sub-envelope that may subsequently be USEd in the COMBINED sub-deck of the inclusion data . Definition of the sub-envelope should previously have been started using the DEFIne command. Definition of a sub-envelope may not straddle sub-decks within the inclusion data, but may contain any valid inclusion data except FINI, DEFI and USE.

The S/U/B (Service/Ultimate/Both) flag is included for compatibility with other commands only. It is not used by the program and may be set to any arbitrary value. The actual envelopes affected are defined by each of the constituent cards within the sub-envelope definition.

The 'group' number is the number of the sub-envelope being defined. A maximum of ten sub-envelopes may currently be defined. This number should correspond to that given on the last DEFIne card.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : IFTA

Syntax : IFTA S/D S/U/B case factor psf phase (text)

Examples : IFTA S U 21 1.20 1.50 0.0 STATIC CASE
IFTA D S 100021 1.0 1.50 90.0 DYNAMIC PAIR

Description:

The IFTA command specifies optional inclusion of a load case into the current envelope. The load case is only included into each envelope IF TAking it extends the current envelope, otherwise it is ignored. In practice, this means that positive load values will extend the maximum envelope, whilst negative values will extend the minimum envelope.

IFTA is not allowed in the COMBINED section as its effects are best simulated in the STATIC and DYNAMIC sub-decks. If required, it can be simulated with a CHOOse instruction, of which it is a simplification.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined.

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command.

The load case number 'case' is described in Section 4.11.

The 'factor' parameter is a constant multiplying factor to be applied to this load case for both serviceability and ultimate envelopes.

The 'psf' item is a partial load factor for ultimate (strength) envelopes. The load case is always multiplied by this factor for the IFTA command as the load case, by definition, always extends the envelope (otherwise it is not considered). The load-factor is not required for service envelopes and must be set to zero. For all other cases 'psf' must take a value between 1.0 and 3.0.

The 'phase' parameter is used to specify a phase shift for dynamic load cases. The direction of this shift (lead or lag) is defined via the PHASE-SIGN-CONVENTION command.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : INCL

Syntax : INCL S/D S/U/B case factor maxpsf minpsf phase (text)

Examples : INCL D B 5.1 1.00 1.50 0.90
INCL S U 5.02 2.25 1.50 0.00 CASE 5.2

Description:

The INCL command specifies mandatory inclusion of a load case into the current envelope whether the case extends or contracts the envelope. It is used to define fixed loads, such as dead load, etc.

INCL is not allowed in the COMBINED section as its effects are best simulated in the STATIC and DYNAMIC sub decks. If required, it can be simulated with a CHOOse instruction, of which is it a simplification.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined.

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command.

The load case number 'case' is described in Section 4.11.

The 'factor' parameter is a constant multiplying factor to be applied to this load case for both serviceability and ultimate envelopes.

The 'minpsf' and 'maxpsf' parameters are minimum and maximum partial safety factors for load applied to the ultimate envelope only. The minimum psf is used when the load case must be included even though it reduces the envelope. The maximum psf is used when the envelope is extended.

The 'phase' parameter is used to specify a phase shift for dynamic load cases. The direction of this shift (lead or lag) is defined via the PHASE-SIGN-CONVENTION command.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : LOAD

Syntax : LOAD

Examples : LOAD S S 100 1.00 1.50 0.90 0.0 CASE 100
LOAD S B 90 1.10 1.50 0.90 0.0 DEAD CASE

Description:

The LOAD command is used to specify load cases to be selected from a CHOOse list. Refer to the CHOO command for details of this form of selection.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined. Either S or D are allowed in the COMBINED section.

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command. The B flag is not permitted in the COMBINED sub-deck, but may be simulated by extending the service and ultimate envelopes separately.

The load case number 'case' is described in Section 4.11.

The 'factor' parameter is a constant multiplying factor to be applied to this load case for both serviceability and ultimate envleopes.

The 'minpsf' and 'maxpsf' parameters are minimum and maximum partial safety factors for load applied to the ultimate envelope only. The minimum psf is used when the load case must be included even though it reduces the envelope. The maximum psf is used when the envelope is extended.

The 'phase' parameter is used to specify a phase shift for dynamic load cases. The direction of this shift (lead or lag) is defined via the PHASE-SIGN-CONVENTION command.

Up to twenty character of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : REVE

Syntax : REVE S/D S/U/B case factor psf phase (text)

Examples : REVE S U 99 1.10 1.20 0.00 DEAD LOAD
REVE D B 200003 1.00 1.00 45.0 90 DEG WAVE

Description:

The REVErsible command specifies a load case that may be reversed before being added to an envelope, is such reversal extends the envelope. The REVE command therefore always extends the envelope.

REVE is not allowed in the DYNAMIC or COMBINED sections as its effects are best simulated in the STATIC and DYNAMIC sub-decks. If required, it can be simulated with a CHOOse instruction, of which it is a simplification.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined.

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command.

The load case number 'case' is described in Section 4.11.

The 'factor' parameter is a constant multiplying factor to be applied to this load case for both serviceability and ultimate envelopes.

The 'psf' parameter is load partial safety factor used to multiply the load case for the ultimate envelope only. Only one psf is required for the REVE command. A minimum psf is not needed, as the envelope can never be reduced by this command.

The 'phase' parameter is used to specify a phase shift for dynamic load cases. The direction of this shift (lead or lag) is defined via the PHASE-SIGN-CONVENTION command.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : STATIC

Syntax : STATIC

Examples : STATIC

Description:

The STATIC card acts as a header to the static sub-deck of the inclusion data. The static sub-deck is defined in Section 2.4 of this guide.

The STATIC card must immediately follow the ENVELOPE card and the sub-deck must precede both the DYNAMIC and COMBINED sub-decks.

Inclusive Command	:	USE
Syntax	:	USE S/U group factor (text)
Examples	:	USE S 4 1.00 USE SUB 4

Description:

The USE command is used to specify that a given sub-envelope is to be USEd in the current sub-deck. USE may only be present in the COMBINED section as part of a CHOOse list. The DEFI/FINI construction that creates the sub-envelope of this group must already be closed.

The S/U (Service/Ultimate) flag defines the type of envelope that will be extended by this command.

The group number is the number of the sub-envelope that is referenced by this command. This must reference a previously DEFIned (and FINIshed) sub-envelope. Sub-envelopes may be used repeatedly as required.

The 'factor' is applied to both serviceability and ultimate stored sub-envelopes referred to by this command. The stored sub-envelopes are multiplied by this factor prior to use.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Inclusive Command : WITH

Syntax : WITH S/D S/U/B case factor maxpsf minpsf phase (text)

Examples : CASE S U 22 1.10 1.50 0.00 LIVE LOAD
CASED B 10000 1.00 1.25 0.00 0 DEG WAVE

Description:

The WITH command may be used to specify that a given load case is to be associated WITH another case and is to follow its inclusion logic. Any number of WITH instructions may follow a single INCL, REVE, IFTA or LOAD command and all follow the hosts instruction's inclusion logic. WITH may not be the first instruction in a deck.

The S/D (Static/Dynamic) flag must be consistent with the sub-deck being defined. Either S or D are allowed in the COMBINED sub-deck

The S/U/B (Service/Ultimate/Both) flag defines the type of envelope that will be extended by this command. The B flag is not permitted in the COMBINED sub-deck, but may be simulated by extending the service and ultimate envelopes separately. This flag must be identical to that set up on the host instruction.

The load case number 'case' is described in Section 4.11.

The 'factor' parameter is a constant multiplying factor to be applied to this load case for both serviceability and ultimate envelopes.

The 'minpsf' and 'maxpsf' parameters are minimum and maximum partial safety factors for load applied to the ultimate envelope only. The minimum psf is used when the load case must be included even though it reduced the envelope. The maximum psf is used when the envelope is extended. The partial safety factors should be identical to those specified on the host command. When WITH is used in conjunction with the IFTA and REVE cards, only one psf is defined on the host command. In this case, 'minpsf' should be set to zero on the WITH command, and 'maxpsf should be identical to the host psf.

The 'phase' parameter, used to define the phase of dynamic loading, should be identical to that specified on the host command.

Up to twenty characters of text may be input at the end of the line as an aid to describing the data.

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Appendix - A SUMMARY OF CONTROL DATA COMMANDS

A.1 INTRODUCTION

The following is a summary of control data commands for PANEL-ENVELOPE. The conventions used for the command syntax are described in Section 5.0.

A.2 RUN CONTROL COMMANDS

AVERAGE newnod class envelope (group)
CHANGE-INPUT-STREAM (stream (filename))
CHART (NONE/OFF/ON/ONA)
DATA-CHECK-ONLY
DEBUG level/OFF (routine (values...))
DO-CHECKS
ECHO (ON-OFF)
END
ENVELOPE (ON/OFF)
LIST-INCLUSION-DATA (ON/OFF)
LIST-INPUT-DATA (ON/OFF)
MAXIMUM-ERRORS maxerr
READ-INCLUSION-DATA (stream (filename))
STOP
SUBROUTINE-TRACE (ON/OFF)

A.3 NODE AND SET SELECTION COMMANDS

ALL
CLEAR-SELECT class node1 (node2 ----)
GROUP set
SAMPLE
SELECT class node1 (node2----)
SET set
STIFFENER-MODEL motype (set1 (set2))
STIFFENER-MODEL OFFSET sea offset
SWEEP

A.4 DATA INPUT COMMANDS

BEAM (DEFAULT/ROTATED)
EFFECTIVE-WIDTH-FACTORS ewfmid (ewfend) F-
E-STIFFENER-SPACING spacing
FLANGE-NODE plnode flnode1 (flnode2)
NUMBER-OF-PHASES sectors
PHASE-SIGN-CONVENTION LAG/LEAD POS/NEG/+/-
ROTATE
STANDARD
WEB-DEPTH depth
WEB-STRESS-ORIENTATION angle

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A.5 FILE HANDLING COMMANDS

KEY-FIELDS keysym1 (keysym2----)
KEY-RANGE min1 max1 (min2 max2----)
NEW-SYMBOL symbol (value)
SYMBOL-VALUE symbol value
WRITE (ON/OFF)

A.6 GLOBAL ENVELOPE COMMANDS

BEGIN-ENVELOPE number (title)
FINISH-ENVELOPE
PRINT-ENVELOPE

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Appendix - B SUMMARY OF INCLUSION DATA COMMANDS

B.1 INTRODUCTION

The following is a summary of inclusion data commands for PANEL-ENVELOPE. The conventions used for the command syntax are described in Section 6.0.

In the following commands:

– S/D allows cases to be defined as Static or Dynamic;

– S/U/B allows inclusion data to be allocated to Serviceability, Ultimate or Both Limit States.

B.2 GENERAL INSTRUCTIONS

ENVELOPE number (title)
STATIC
DYNAMIC
COMBINED
END

B.3 DIRECT LOAD CASE INCLUSION

INCL S/D S/U/B case factor maxpsf minpsf phase (text)
REVE S/D S/U/B case factor psf phase (text)
IFTA S/U/B case factor psf phase (text)

B.4 SELECTED LOAD CASE INCLUSION

CHOO S/D S/U/B minnum maxnum (text)
LOAD S/D S/U/B case factor maxpsf minpsf phase (text)
USE S/U group factor (text)

B.5 SUB-ENVELOPE CREATION

DEFI S/U/B group (text)
FINI S/U/B group (text)

B.6 COMBINATION INCLUSION

WITH S/D S/U/B case factor maxpsf minpsf phase (text)

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Appendix - C EVALUATION OF FORCES/STRESS PER UNIT WIDTH

C.1 INTRODUCTION

PANEL-ENVELOPE inputs force and stress data from a given FE analysis system and produces envelopes of load for checking by PANEL-CHECK or other programs. As previously stated (Section 2), it is an advantage in PANEL-CHECK to produce load data for each envelope to allow redesign without the need to know the original stiffener sizes or spacing. This is achieved by producing loads per unit width which are then independent of stiffener or plate geometry.

PANEL-ENVELOPE must therefore produce load per unit width data for each required envelope from the FE analysis results. The FE analysis results depend on the modelling of the structure and on the FE system in use.

The following sections describe how PANEL-ENVELOPE converts FE results to stiffened panel loading for the following geometries:

– smeared stiffeners;

– plate modelled with shell elements; stiffeners modelled as coplanar beams;

– plate modelled with shell elements, but with offset stiffeners modelled as beams;

– plate modelled with shell elements; stiffener webs modelled with shell elements; stiffener flanges modelled as beams.

In all cases, it is assumed that the FE analysis produces averaged nodal membrane stresses in the shell elements and averaged nodal forces for the beams. Where other information is available from the FE System, this is first converted to the above format by PANEL-ENVELOPE.

C.2 SMEARED STIFF ENERS

PANEL-ENVELOPE can cope with FE models where the stiffeners have not been modelled directly, but have been included in the stiffness of the plate, either by artificially increasing the plate thickness (smearing) or by increasing the modulus of the plate material (perhaps anisotropically). This modelling also covers the case where minor stiffeners have not been modelled at all, but must still be checked using local plate stresses to give the level of stress in the stiffeners and plate.

When the modelling type is SMEARED, PANEL-ENVELOPE will only extract plate element stresses, even for classes 2, 4 and 5. The loads per unit width of plate will then be calculated from these plate stresses only (with due allowance for whether the plate axis direction is STANDARD or ROTATEd). If us, up and asp are the plate stresses in the stiffener, perpendicular and shear directions, the loads per unit width are as follows:

$$N_S = t\,\sigma_S$$

$$N_P = t\,\sigma_P$$

$$N_{SP} = t\,\sigma_{SP}$$

where t is the modelled plate thickness at the point considered.

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The remaining terms, M and S, are set to zero for smeared stiffeners.

C.3 COPLANAR BEAM ELEMENTS

Figure C.3-1 shows the geometry and loading of the actual structure and its modelled equivalent.

The stiffener is modelled as a set of beam elements coplanar with the plate, which is represented by shell elements. For the beam elements, the subscripts 'a', 'i' and 'o' refer to the axial, in-plane and out-of-plane exes respectively. For the plate, the subscripts 's', 'p' and 'sp' refer to the stiffener, perpendicular and shear directions. The modelled stiffener spacing is designated by 'b' and the plate thickness by 't'.

The following loads per unit width for the stiffened plate are derived:

$N_S = t\,\sigma_S + F_A/b$

$N_P = t\,\sigma_P$

$N_{SP} = t\,\sigma_{SP}$

$M = M_{II}/b$

$S = F_O/b$

F_I, M_{OO} and M_{AA} are assumed small and are not used.

C.4 OFFSET BEAM STIFFENERS

Figure C.4-1 shows the geometry and loading of the structure and its modelled equivalent.

The stiffener is modelled as a set of beam elements offset away from the panel by a fixed offset at each node. This offset is assumed rigid and is designated as 'e'. The area of the stiffener is identified as As. The offset is always taken as positive in PANEL-ENVELOPE as the signs for the moments, etc. are given by the relative plate/beam stresses, not the element orientation.

Plate stresses adjacent to the stiffener are again designated σ_S, σ'_P and σ_{SP}. The σ_S is, however, only valid local to the stiffener and reduces due to shear lag effects further into the plate. For the purposes of the program, and effective width factor may be specified and is the width over which bending stress in the plate is considered to be active. Refer to Figure C.4-2 for a description. The effective width of plate, b_E, is given by:

$b_E = b\lambda$

where: b is the stiffener spacing;

λ is the effective width factor.

Middle and end λ values may be given. For nodes of class 2, the end value is used. For nodes of class 4 or 5, the middle value is used.

All other terms and subscripts are as for the coplanar stiffener.

The area and centroid of the effective bending cross-section is then given by:

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area, $A = A_S + b_E t$
centroid, $y = (A_S e)/A$

Axial load acting at the centroid will given uniform stress in both plate and stiffener. Any differece between the stresses in the plate and stiffener will therefore be due to bending only. It may therefore be shown that the stress in the plate due to bending is given by:

$$\sigma_{BP} = \frac{(\sigma_S A_S - F_S)y}{A_S E}$$

The stress in both plate and flange due to axial loading is then given by:

$$\sigma_A = \sigma_S - \sigma_{BP}$$

The total axial resistance of the section is then:

$$F = (\sigma_A b + \sigma_{BP} b_E)t + F_S$$

The stress in the stiffener due to bending is:

$$\sigma_{BS} = F_S / A_S - \sigma_A$$

and the resistance moment of the section is then:

$$B = \sigma_{BP} b_E t y + \sigma_{BS} A_S (y-e) + M_{II}$$

Or $$B = \sigma_{BP} b_E t y + \sigma_{BS} A_S (y-e) - M_{II}$$

whichever gives the greater absolute value of B.

where M_{II} is the in-plane bending moment on the stiffener (in practice, M_{II} is added with the same sign as the rest of B).

The N_S and M terms per unit width may then be calculated from F and B above. Other term are derived as for the coplanar stiffener:

$$N_S = F / b$$

$$N_P = t \sigma_P$$

$$N_{SP} = t \sigma_{SP}$$

$$M = B / b$$

$$S = F_O / b$$

C.5 SHELL ELEMENT WEB, BEAM ELEMENT FLANGE

Figure C.5-1 shows the geometry and loading of the actual structure and its modelled

equivalent.

The stiffener is modelled using shell elements for the web and beam elements for the flange. For the web, the subscripts 'a' and 't' refer to the axial and shear stress directions respectively. For the beam flange, only axial force, F_A, is important. The plate axes, spacing and thickness are as before.

As in the offset case, plate stress adjacent to the stiffener (given by σ_S) is only valid local to the stiffener. This is because the bending stress in the plate reduces away from the stiffener. Figure C.5-2 idealises this effect. In terms of the program, the axial and bending loads are idealized as shown, with the bending stress acting over an effective width, b_E, only.

Note that the web-to-plate and web-to-flange stresses in the model often show a step change at the intersections. Such a step change cannot occur in reality and is a function of the extrapolation of gauss point stresses to nodes prior to averaging. This causes an imbalance in nodal stresses. PANEL-ENVELOPE considers this imbalance to be axial load only, as detailed below.

Given the geometry shown in Figure C.5-1, PANEL-ENVELOPE first calculates the composite section properties of the stiffener and effective width of plate as follows:

$$\text{Area} \qquad A = A_S + \tfrac{1}{2} d\,(t_{WF} + t_{WP}) + b_E\, t$$

$$\text{Centroid,} \qquad y = (A_S\, d + \tfrac{1}{3} d^2\,(t_{WF} + \tfrac{1}{2} t_{WP})\,) / A$$

where A_S is the flange area and tw_F and twp are the web thickness at the flange and plate respectively.

The web stress at the centroid of the bending section is then interpolated from the flange and plate web stresses:

$$\sigma_{AC} = \sigma_{AP} + (\sigma_{AF} - \sigma_{AP})\, y / d$$

This stress is taken to be the axial stress in the stiffener web. The bending component at the plate is given by:

$$\sigma_{SB} = \sigma_{AP} - \sigma_{AC}$$

As mentioned above, the bending stress is assumed consistent between the web and plate, but the axial stress is not. The axial stress in the plate is therefore not given by σ_{AC}, but is calculated as follows:

$$\sigma_{SA} = \sigma_S - \sigma_{SB}$$

Similar considerations apply at the flange. The flange bending stress is given by:

$$\sigma_{FB} = \sigma_{AF} - \sigma_{AC}$$

and the remaining stress is axial:

$$\sigma_{FA} = F / A_S - \sigma_{FB}$$

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The total axial load comprises components in the flange, web and plate (due to axial and bending stresses). The web and plate forces are calculated as follows:

$$F_W = (\sigma_{AP} (t_{WF} + 2t_{WP}) + \sigma_{AF} (t_{WP} + 2t_{WF})) d/6$$

$$F_P = \sigma_{SA} b t + \sigma_{SB} b_E t$$

The above loads can then be summed with F to give the total load on the section. This may be converted to load per unit width as follows:

$$N_S = (F + F_W + F_P) / b$$

Similar calculations can be applied to the bending moment per unit width, M. Forces in the flange, web and plate due to bending only are as follows:

$$F_{FB} = \sigma_{FB} A_S$$

$$F_{WB} = (\sigma_{SB} (t_{WF}+2t_{WP}) + \sigma_{FB} (t_{WP}+2t_{WF})) d/6$$

$$F_{PB} = \sigma_{SB} b_E t$$

The centroid of the web bending force is given by:

$$y_W = (\sigma_{SB} (t_{WF} + t_{WP}) + \sigma_{FB} (t_{WF}+3t_{WP}) d^2 / (12F_{WB})$$

and the moment per unit width is given by:

$$M = (F_{PB} y + F_{WB} (y - y_W) + F_{FB} (y - d)) /b$$

The out-of-plane shear is evaluated by summing the shear up the web, whilst the remaining in-plane shear and transverse load are simply taken from the plate loads:

$$S = (\sigma_{TP} (2t_{WP} + t_{WF}) + \sigma_{TF} (2t_{WF} + t_{WP})) d / (6b)$$

$$N_P = t \sigma_P$$

$$N_{SP} = t \sigma_{SP}$$

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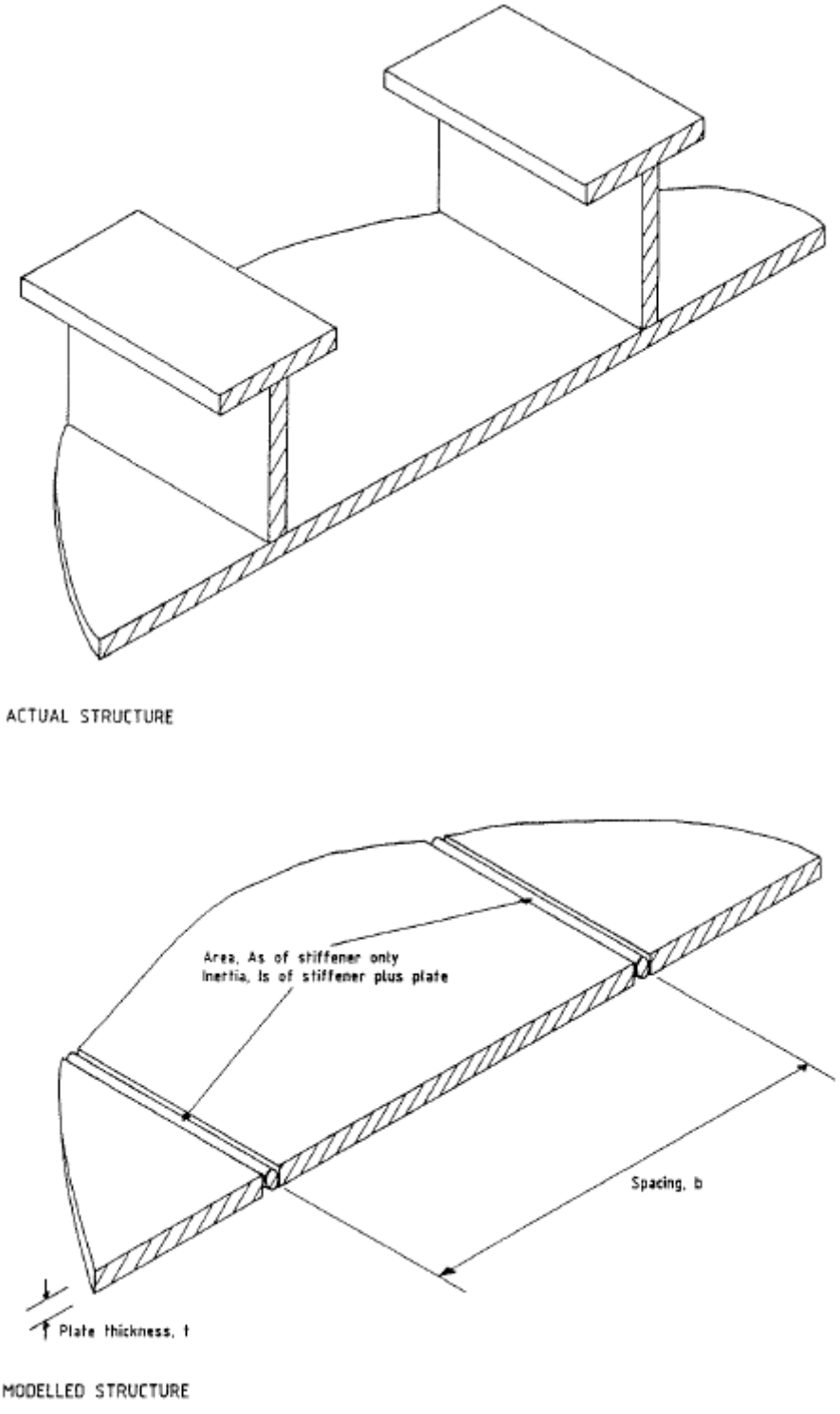

FIGURE C.3-1: COPLANAR BEAM MODELLING

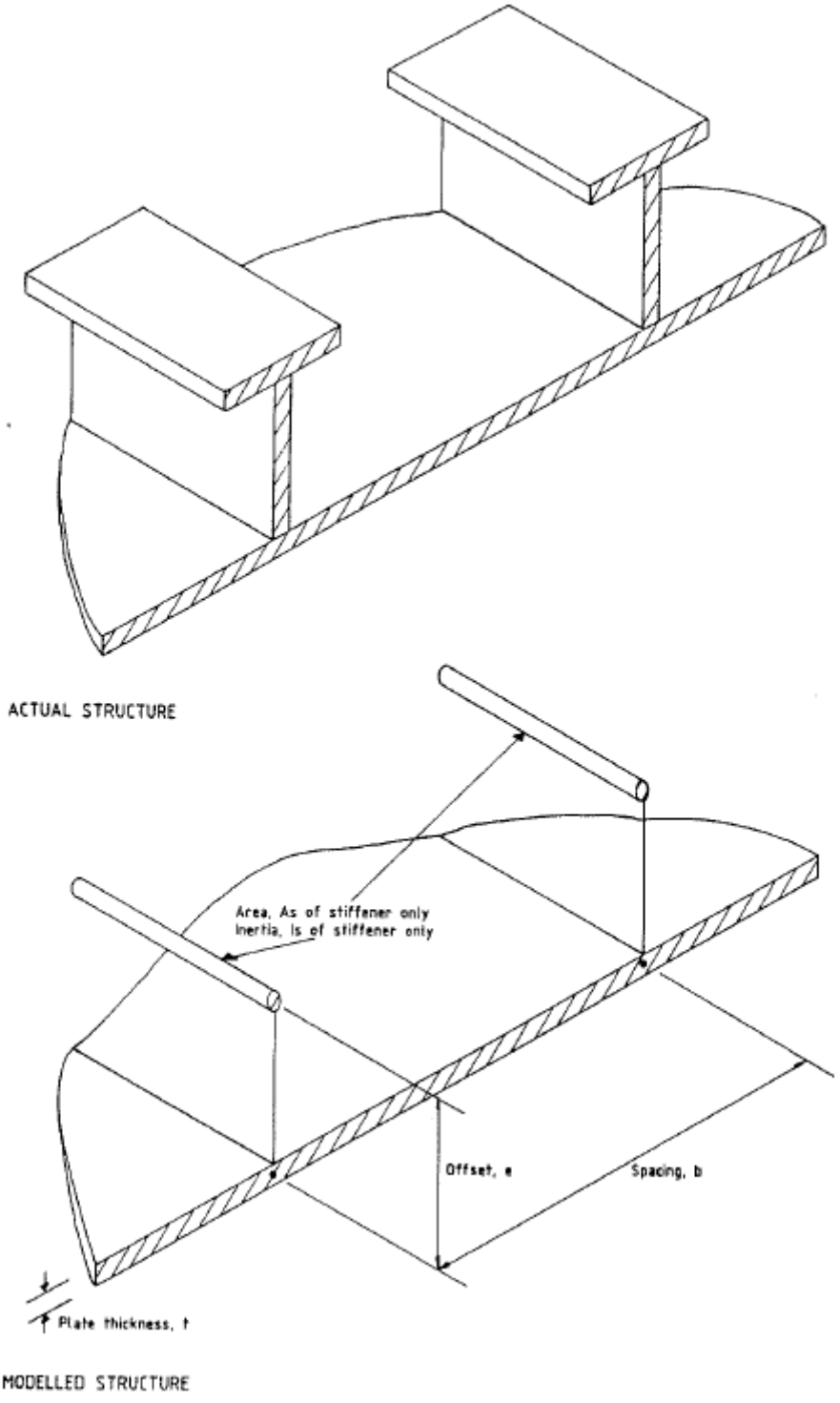

FIGURE C.4-1: OFFSET BEAM MODELLING

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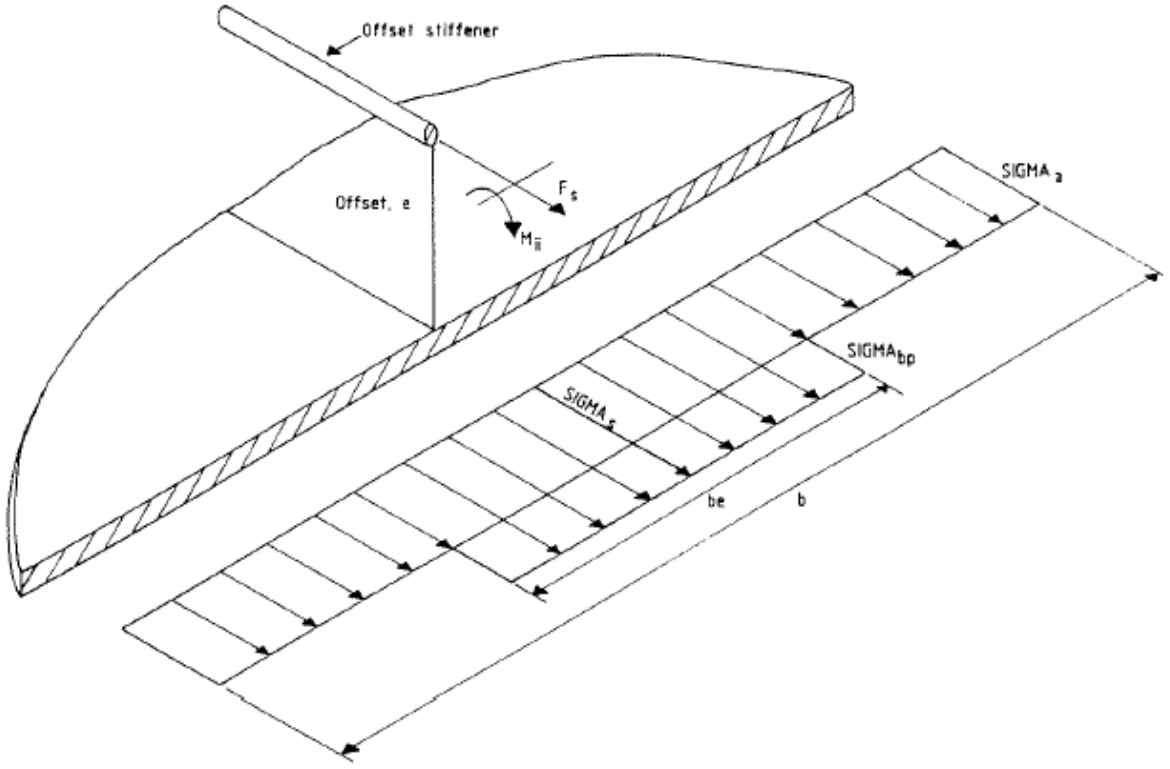

FIGURE C.4-2: OFFSET BEAM AND PLATE STRESSES

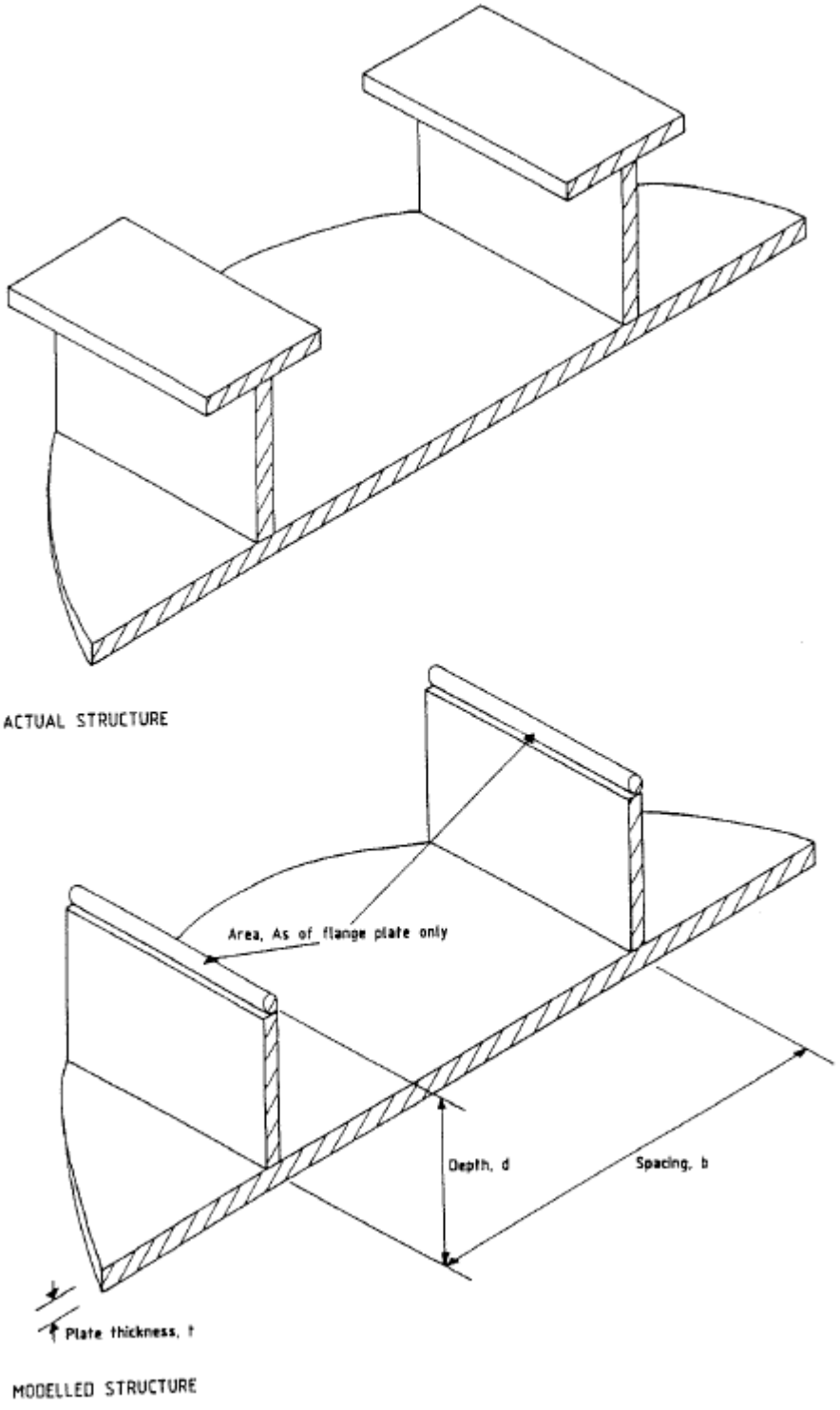

FIGURE C.5-1: SHELL WEB, BEAM FLANGE MODELLING

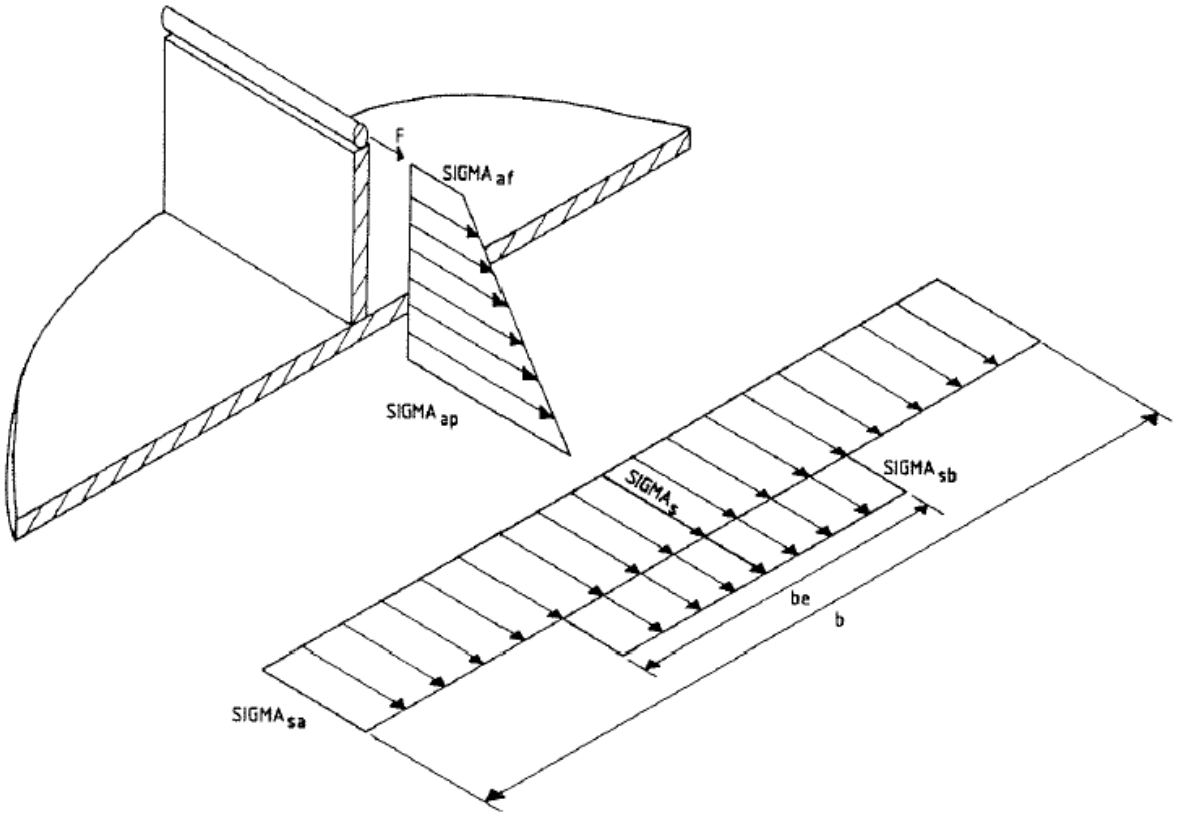

FIGURE C.5-2: STRESS DISTRIBUTION IN STIFFENER/PLATE

Appendix - D ASAS INTERFACE

D.1 INTRODUCTION

The PANEL-ENVELOPE program is available as a post-processor to the ASAS package of programs. A wide range of ASAS shell, membrane and frame elements may be used to model the stiffened plate. Section D.2 lists all available elements.

PANEL-ENVELOPE requires that ASAS be run with an option to save stress results. If both shell and beam results are required, the SAVE LOCO FILES option is the most appropriate. It is also possible to analyse unstiffened plates, when a SAVE SHEL FILES card is sufficient.

PANEL-ENVELOPE assumes that ASAS POST has been run to post-process the shell or membrane elements and convert plate stresses to nodal stresses per group in a uniform axis system. ASAS POST must have a SAVE INTE FILES option specified to create a '12' file containing nodal stresses. It is currently also necessary to have a SAVE 1 FILES 34 card in the preliminary deck. Refer to the ASAS documentation for more details.

Care should be taken to ensure that the FE model is properly and adequately subdivided into groups when the model data is created (it is not sufficient to use the POST regrouping facility). The basic rules for grouping are as follows:

- plate groups should not contain elements of different thicknesses (unless all element thicknesses at any given node are the same due to tapered elements);
- plate groups should be discontinuous at corners or at abrupt changes in curvature;
- plate groups should be discontinuous where three or more panels or plates intersect (say at a boundary between walls, walls and floors, etc.);
- multiple web plates may be present at one group as long as the webs of different stiffeners do no intersect;
- the webs of double sided WEB-PLATE stiffeners should be in the same group. The two flanges should be in another single group;
- plates, webs, beams and flanges should not be in the same group as any other type;
- multiple beams and flanges may be in the same group as long as different stiffeners do not cross at a common node.

A full ASAS preliminary check is needed at the start of the PANEL-ENVELOPE run control data. The format of this deck is given in Section D.3. The deck allows the selection of project, structure and component, as well as providing a job title, etc.

The ASAS sign convention for stresses is described briefly in Section D.4 and details are given as to how to convert this to the PANEL-ENVELOPE system for post-processing.

The final section of this Appendix (D.5) describes the files required for a successful run of PANEL-ENVELOPE and describes the files produced.

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D.2 AVAILABLE ELEMENT TYPES

PANEL-ENVELOPE works directly from the ASAS POST results for membrane or shell elements and can therefore handle most element types that can be processed under the ASAS POST 'SHELL' element type. Three, four, six and eight nodded elements of the following types may be handled:

GCS6, GCSE, TCS6, TCS8, TBC3, QUS4
QUM8, QUM4, TRM6, TRM3
SND6, SND8

Although the SLB8 and TRB3 elements are theoretically available, PANEL-ENVELOPE processes only the mid plane stresses from shell elements and will therefore return zero stress for these elements.

PANEL-ENVELOPE can handle the majority of ASAS two and three noded bar, beam and rod elements to represent stiffeners. The following list of elements is available:

FLA2, FLA3, GRIL, BM2D, BM3D, BEAM,
CURB, GCB3, BMGN, TCBM, TUBE

Some of the above elements do not produce all of the stress/force components required by PANEL-ENVELOPE. For example, the FLA elements do not produce bending or shear and the GRIL and BM2D elements produce bending results in one plane only. Where forces are not available, they are set to zero.

The only exception to this are the shear forces on GCB3 elements, which are not directly available but are derived by finding the slope of the bending moment diagram at the required node.

The orientation of shell stresses and beam axes is described in Section D.4.

D.3 PRELIMINARY DECK

The preliminary data deck provides information required about the size of the job and the names of the backing files to be used or created.

The commands which provide the information must be given in the following order:

SYSTEM DATA AREA nnnnn
JOB POST namel name2
TITLE text
STRUCTURE name3
COMPONENT name3 tree (only required for substructure analyses)
OPTION options ENDS
END

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Each command starts at the beginning of a new line and is free format, each item being separated by at least one space.

Explanation:

nnnnn: is the decimal number of words of memory to be made available to the program. This number is not required on installations where the memory requirements are defined in the Job Control Statements. Typical values are between 30000 and 100000 depending on job size.

namel: is a four character project name. Details of all runs identified by project name are stored in a common project file.

name2: is a four character project name used to identify any backing files created for envelopes by this run. If name2 not defined, namel is assumed.

text: is any alphanumeric text of up to sixty characters, which will be printed at the top of each page of output.

name3: is a four character structure name identifying which structure is to be accessed from the project defined by namel.

tree: is the path down the component tree from the structure defined by name3 to the assumed component which is being used for the PANEL-ENVELOPE run.

options: the only useful option currently available is NOBL, which suppresses the ASAS banner at the top of the output.

D.4 SIGN CONVENTION AND ORIENTATION

The sign convention for stress in ASAS is tensile-positive, compression-negative. The sign convention for shear and bending depends largely on the element type as defined in Appendix A of the ASAS manual. PANEL-ENVELOPE maintains this sign convention when converting element stresses into loads per unit width on the composite plate/stiffener section. Envelopes are therefore stored in the ASAS systems and with the ASAS sign convention and units. If these envelopes are subsequently used by PANEL-CHECK, they must be converted in the PANEL-CHECK data to the PANEL system.

For coplanar beam modelling, direct stresses will be tensile-positive, compression-negative. Moments will have the same sign convention as the original ASAS beams.

For offset beams and stiffener with the webs modelled by plate elements, PANEL-ENVELOPE will again generate tensile-positive, compression-negative direct stresses. Moments will be positive if the plate stresses are positive.

Initially, the σxx stress for the plate is assumed to be in the direction of the stiffeners and stresses combined accordingly (see Appendix C). The ROTATE command will switch the σ_{YY} stress into the direction of the stiffeners, with STANDARD returning to the default condition.

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A similar assumption will be made for web stresses if the web is modeled with plate elements. The WEB-STRESS-ORIENTATION angle may be used to rotate the X-axis of the stresses away from the stiffener direction to any user-specified orientation.

The DEFAULT and ROTATED beam axes are given in the following table for both shear and bending moment. By default, the first set of axes will be used. If the BEAMs are ROTATED, the second set of axes will be selected.

Element Type	DEFAULT		ROTATED	
	Shear	Moment	Shear	Moment
FLA2	-	-	-	-
FLA3	-	-	-	-
GRIL	QZ	YY	QZ	YY
BM2D	QY	ZZ	QY	ZZ
BM3D	QY	ZZ	OZ	YY
BEAM	QY	ZZ	QZ	YY
CURB	QX	ZZ	QZ	XX
GCB3	(a)	ZZ	(b)	YY
BMGN	QY	ZZ	QZ	YY
TCBM	XZ	YY	XY	ZZ
TUBE	QY	ZZ	QZ	YY

TABLE OF BEAM FORCED USED

(a) = derived from the slope of the ZZ moment diagram
(b) = derived from the slope of the YY moment diagram
(-) = not available.

D.5 FILE HANDLING

PANEL-ENVELOPE acts on the files produced by the preceding ASAS and ASAS POST analyses. Optionally, ASAS LOCO may be run after ASAS to combine load cases (although this may also be performed in PANEL-ENVELOPE). Since ASAS LOCO produces identically formatted files to ASAS, either can be used as required.

The appropriate physical files from the ASAS or (ASAS LOCO) and ASAS POST runs must be present on disc for ENVELOPE to run. To produce these files, the programs should have been run with appropriate SAVE options (see Section D.1).

In all cases there will be the Project File which contains information about all jobs in the current set of analyses. The name of this file is derived from the four character Project Name defined on all JOB cards in the runs. For example, if the project name is PRDH, then the Project File will be PRDH10.

For an ASAS or ASAS LOCO analysis with a 'SAVE LOCO FILES' card in its

preliminary deck, there will be a physical file containing the stress and displacement information from that analysis. For a single step analysis, the physical file name will be derived from the second four character name on the JOB card of the ASAS or ASAS LOCO preliminary deck, or from the FILES card.

For example, if this name had been RNDH, then the backing file containing stresses (and displacements) would be RNDH35. For a post-processing run on a substructured analysis, the file name for the results is derived from the second four character name on the JOB card of the relevant stress recovery run. If this name has been SRGP then the file would be SRGP35.

For an ASAS POST run with a SAVE INTE FILES card in its preliminary deck, there will be a physical file containing nodal stress data. This file will be based on the four character name given on the JOB card of the ASAS POST data file. If the name is ASPO, then the file name will be ASPO12. Multiple ASAS POST runs may produce more than one '12' file.

Note that the physical file stems for these files are not needed in the PANEL-ENVELOPE preliminary deck, as the project ('10') file contains information about file names to allow subsequent programs to access any given set of results. However, the appropriate '10, '12' and '35' files must be present on disc for ENVELOPE to run successfully.

PANEL-ENVELOPE will produce a '12' file containing envelope results if the analysis has appropriate options set (WRITE ON, ENVELOPE ON). This file will be required by subsequent PANEL-CHECK analysis. The file name produced by PANEL-ENVELOPE will be derived from 'name2' in the preliminary deck. If this name had been SREN, then the file would SREN12.

Unsuccessful runs of PANEL-ENVELOPE may create a 'proj11' file, where `proj' is the project name. This file is not needed, and may be deleted.

PANEL-ENVELOPE appends to (or creates, if necessary) a journal file, 'projJF'. This contains a record of all runs under this project name. Refer to any ASAS documentation for more details.

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Appendix - E SESAM FE INTERFACE

E.1 INTRODUCTION

PANEL-ENVELOPE is available as a post-processor to the SESAM FE system. A wide range of SESAM shell and beam elements may be used to model the stiffened plate. Section E.2 lists all available element types.

Section E.3 contains details of the preliminary deck required for the SESAM version of PANEL-ENVELOPE.

PANEL ENVELOPE obtains geometric and element stress data from a NORSAM formatted SESAM Interface File (known as the 'SIN' file after its extension) produced by PREPOST. However, PREPOST will not produce nodally averaged stresses. These must be added by the SIF-AVERAGE program, which allows the user to select groups of elements and nodally averaged stresses in consistent axes, for selected load cases. The user should refer to the SIF-AVERAGE manual for details. Section E.4 of this Appendix does, however, contain details of the format of loadcase stresses on the SIF, where this is of use in running PANEL-ENVELOPE.

Care should be taken to ensure that the FE model is properly and adequately subdivided into groups by SIF-AVERAGE. The basic rules for grouping are as follows:

- plate groups should not contain elements of different thicknesses (unless all element thicknesses at any given node are the same, due to tapered elements);
- plate groups should be discontinuous at corners or at abrupt changes in curavature;
- plate groups should be discontinuous where three or more panels or plates intersect (say at a boundary between walls, walls and floors, etc);
- multiple web plates may be present in one group as long as the webs of different stiffeners do not intersect;
- the webs of double-sided WEB-PLATE stiffeners should be in the same group. The two flanges should be in the same group, which must be separate from that containing the webs;
- plates, webs, beams and flanges should not be in the same group as any other type;
- multiple beams and flanges may be in the same group as long as different stiffeners do not cross at a common node.

The final section of this Appendix (E.5) gives details of the files required for PANEL-ENVELOPE to run successfully.

E.2 AVAILABLE ELEMENT TYPES

PANEL-ENVELOPE can handle stresses produced by all SESAM shell, plate and membrane elements that can be processed by SIF-AVERAGE. Currently, this list is as follows:

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CSTA, LQUA, ILST, IQQE,
FTRS, FQUS, SCTS, SCQS

The list of available beam elements that can be processed is again the same as can be handled by SIF-AVERAGE, namely:

TESS, BEAS, SECB

The TESS element type is a strut and contains axial load only. If this element is used to model coplanar stiffeners, the bending moments are set to zero.

The orientations of shell stresses and beam axes are described in Section E.4.

E.3 PRELIMINARY DECK

The preliminary deck contains information about the superelement to be processed by this run of PANEL-ENVELOPE.

A single command is needed to provide this data as below:

SUPER-ELEMENT prefix filename (superelement)

where: 'prefix' is a file prefix for the required SIF;
'filename' is the SIF filename;
'superelement' is the hierarchy reference number of the required superelement

If only one superelement exists within the SIF, the last parameter is not required.

E.4 STRESS EXTRACTION

PREPOST may be used to crate load combinations and store these on the SIN file. These combined cases and the original constituent cases are then available for code checking. This is useful for the following reasons:

– the PANEL suite does not handle complex load cases in the same form as SESAM. Single complex cases from the analysis should be converted to separate real and imaginary cases by PREPOST so that they can be processed by SIF-AVERAGE. This is possible by careful use of the CREATE RESULT-COMBINATION command in PREPOST;

– the PANEL suite does not support run numbers and occurrence numbers of load cases. Again, PREPOST can be used to create load combinations that have a constant run number to avoid this restriction.

Once the necessary combined cases have been created, SIF-AVERAGE can be used to subdivide the superelement into groups of beam or shells (across which nodal averaging is valid). Nodally averaged stresses should then be produced at all nodes on the shell element groups for selected load cases.

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For more information, refer to the SIF-AVERAGE User Manual. The stresses and group information will be stored back to the SIN, where they can be accessed by PANEL-ENVELOPE.

The sign convention for stress in SESAM is tensile-positive, compression-negative. The sign convention for shear and bending in beams depends largely on the element type, as defined in the SESAM manuals. PANEL-ENVELOPE maintains this sign convention when converting element stresses into loads per unit width for the composite plate/stiffener section. Envelopes are therefore stored in the SESAM system and with the SESAM sign convention and units. If these envelopes are subsequently used by PANEL-CHECK, they must be converted in the PANEL-CHECK data to the PANEL system.

For coplanar beam modelling, direct stresses will be tensile-positive, compression-negative. Moments will have the same sign convention as the original SESAM beams.

For offset beams and stiffeners with the webs modelled by plate elements, PANEL-ENVELOPE will again generate tensile-positive, compression-negative direct stresses. Moments, however, will be positive if the plate stresses are positive.

Initially, the SIGMA(Mx) stress for the plate is assumed to be in the direction of the stiffeners and stresses combined accordingly (see Appendix C). The ROTATE command will switch the SIGMA(My) stress into the direction of the stiffeners, with STANDARD returning to the default condition.

A similar assumption will be made for web stresses if the web is modelled with plate elements. The WEB-STRESS-ORIENTATION angle may be used to rotate the SIGMA(Mx) away from the stiffener direction to any user-specified orientation.

The DEFAULT and ROTATED beam stresses are given in the following table for both shear and bending moment. By default, the first set of stresses will be used. If the BEAMs are ROTATED, the second set of stresses will be selected.

Element Type	**DEFAULT**		**ROTATED**	
	Shear	**Moment**	**Shear**	**Moment**
TESS	-	-	-	-
BEAS	TAU(bxz)	SIGMA(by)	TAU(bxy)	SIGMA(bz)
SECB	N_{XZ}	M_{YY}	N_{XY}	M_{ZZ}

TABLE OF BEAM FORCES USED

(-) Not available

E.5 FILE HANDLING

PANEL-ENVELOPE acts on the SESAM Interface File produced by the enhanced PREPOST program and modified by the AVERAGE program to contain nodally averaged stresses for groups or sets of elements in a consistent axis system. For PANEL-ENVELOPE to run, this file must be present on the default disc.

Several SIN files may be produced for different superelements, but the referenced superelement SIN must be present on disc.

PANEL-ENVELOPE also writes results to the SIN, and these may also be accessed by PANEL-CHECK if the file is on the current disc.

The file name for the SIN is created using the data on the SUPERELEMENT command, as follows:

(prefix)(filename). SIN

The extention (.SIN) signifies a NORSAM formatted direct access file. The PANEL suite of programs can work only with this file type.

SIF-AVERAGE can also be used to combine superelements together into one file for post-processing by the PANEL suite. This concurrent superelement facility is also described in the SIF-AVERAGE manual.

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